TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1885.

No. 297.

CHARLES WILLIAM SIEMENS AND FREDERICK SIEMENS,
APPELLANTS,

vs.

WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, JUNIOR, JOSEPH F. TOBIAS, AND JAMES A. WRIGHT.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE EASTERN DISTRICT OF PENNSYLVANIA.

FILED SEPTEMBER 24, 1883.

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1 In the Circuit Court of the United States in and for the Eastern District of Pennsylvania, in the Third Circuit. In Equity.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS
vs.
WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, Jr., JOSEPH F. TOBIAS, and JAMES A. WRIGHT.

UNITED STATES OF AMERICA, }
Eastern District of Pennsylvania, } *ss:*

Pleas and proceedings before the honorable the judges of the circuit court of the United States in and for the eastern district of Pennsylvania, in the third circuit of October session, 1880, No. 8. In equity.

It is thus contained:

Be it remembered that, on the 28th day of September, A. D. 1880, the complainants, by their solicitors, C. S. Whitman and Silas W. Pettit, Esq's, come into our said court here and file their bill of complaint against Williams Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright, which being read is as follows, to wit:

2 In the Circuit Court of the United States for the Eastern District of Pennsylvania. Of October Session, 1880. In Equity.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS, Plaintiffs,
vs.
WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, Jr., JOSEPH F. TOBIAS, and JAMES A. WRIGHT, Defendants.

To the judges of the circuit court of the United States for the eastern district of Pennsylvania:

Charles William Siemens, of Westminster, in the county of Middlesex, England, and a subject of the Queen of Great Britain, and Frederick Siemens, of Dresden, in the German Empire, and a subject of the Emperor of Germany, bring this their bill of complaint against William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright.

And thereupon your orators complain and say that they were and are the first and original inventors of a certain new and im-
3 proved regenerator furnace for metallurgists and others, fully described in the letters patent hereinafter mentioned, the same being a new and useful improvement, which was not known or used before their said invention, and was not at the time of their application for a patent, as hereinafter mentioned, in public use or sale with their consent and allowance, and that your orators being so, as aforesaid, the inventors thereof, on the first day of March, 1864, upon application therefor, did obtain certain letters patent therefor under the seal of the Patent Office of the United States, signed by the Secretary of the Interior, and countersigned by the

Commissioner of Patents of the United States, bearing date the day and year aforesaid, whereby there was secured to your orators, their heirs, administrators, and assigns, for the full term of seventeen years from and after the date of the said letters patent, the full and exclusive right, liberty, and privilege of making, constructing, using, and vending to others to be used, the said improvements, and by virtue thereof your orators became and were the sole owners of all the rights and privileges granted and secured in and by said letters patent.

And your orators further show that they afterwards surrendered the said letters patent on account of their being inoperative and invalid by reason of a defective or insufficient description and specification, which error arose from inadvertency, accident, or mistake, and without any fraudulent or deceptive intention, and thereupon such proceedings were had that on the twelfth day of January, 1869, the Commissioner of Patents duly granted and issued to your orators new letters patent under the seal of the Patent Office of the United States, signed by the Secretary of the Interior, and countersigned by the Commissioner of Patents of the United States, for the said invention, with an amended specification thereto annexed, as by the said reissued letters patent, here in court to be produced, if required, will more fully and at large appear.

And your orators further show unto your honors that by virtue of the said letters patent your orators became, and now are, the sole and exclusive owners of the said letters patent, and all rights and privileges granted and secured, and intended to be granted and secured, thereby.

And your orators further show unto your honors that within eighteen months from the date of the said original
4 letters patent they did put, and from thence hitherto and yet do continue, on sale to the public, on reasonable terms, the said invention for which the said original letters patent issued, and that they did not neglect for the space of eighteen months from the date of the said original patent to put and continue on sale to the public on reasonable terms the said invention.

And your orators further show that the public has universally acknowledged and acquiesced in the rights of your orators, and to the extent that over sixty prominent manufacturers, being a large proportion of the manufacturers whose business is such as to render it necessary or expedient for them to have and use any furnaces for the same purposes as those invented by your orators are adapted to, or intended so to be, have taken licenses from your orators to use furnaces containing the invention and improvements hereinbefore recited, and secured to your orators by the letters patent aforesaid, and are now using furnaces containing such inventions and improvements under agreements to pay to your orators a specified sum for the license and privilege so as aforesaid granted, and that your orators will receive large gains and profits from the said inventions by reason of the premises aforesaid if infringements by the defendants shall be prevented.

And your orators further show that the invention so secured by

the aforesaid letters patent *are* of great value to your orators, to wit, of the vale of five hundred thousand dollars.

Yet the said defendants, well knowing the premises and the rights secured to your orators as aforesaid, but contriving to injure your orators and to deprive them of the benefits and advantages which might and otherwise would accrue unto them from said invention, did in the city of Philadelphia, and within the eastern district of Pennsylvania, on the first day of July, A. D. 1878, and on divers days since, as your orators are informed and believe, in violation of the rights of your orators and in infringement of said letters patent hereinbefore recited, unlawfully and wrongfully manufacture, construct, and use furnaces embracing in their construction and mode of operation the said invention and improvement, the exclusive right of which is vested in your orators by virtue of said letters
5 patent hereinbefore recited, and that the defendants are threatening to manufacture, construct, and use such furnaces to the effect of depriving your orators and their licensees of the benefits and advantages of said letters patent.

And your orators further show that the furnaces which the said defendants have constructed and used and are constructing and using embrace in their construction and mode of operation substantially the same invention as those constructed, used, and sold by your orator- and their licensees, and that the said defendants have melted, manufactured, and reheated large quantities of steel in the furnaces so constructed and used by them, and still continue to melt, manufacture, and reheat steel therein, and refuse to pay your orators any of the profits arising from such unlawful user of the said invention or to desist from such unlawful user.

And your orators further show that they have caused notice to be given to the said defendants of said infringement and of the rights of your orators in the premises, and have requested them to desist and refrain therefrom, but they have disregarded said notice and refused to desist from such infringement, and still continue to make and use said furnaces for the manufacture of steel in disregard of the rights of your orators under said letters patent.

And your orators further show that the aforesaid acts of the defendants are to the great loss of your orators, by which they have been and still are deprived of great profits, which they might and otherwise would have obtained, but which have been and are received by said defendants by and through their unlawful acts as aforesaid, and your orators pray a discovery of how many and what furnaces the defendants have constructed and used, and when and of the profits arising to them therefrom, and of how many tons of steel have been melted, manufactured, and reheated in such furnaces and the profits arising therefrom.

And forasmuch as your orators are entirely remediless at the common law, and can have no relief except in this court:

To the end, therefore, that the said defendants may, if they can, show why your orators should not have the relief prayed for, and may upon their corporal oaths, according to their best and
6 utmost knowledge, remembrance, information, and belief, full, true, direct, and perfect answers make to the premises and to

all the several matters hereinbefore stated and charged, as fully and particularly as if interrogated as to each and every of said matters, and may be compelled to account for and pay to your orators the profits by them acquired and the damages suffered by your orators from the aforesaid unlawful acts:

May it please your honors to grant unto your orators the writ of injunction issuing out of and under the seal of this honorable court in due form of law, comanding, enjoining, and restraining the said defendants and their servants, agents, and attorneys, and each and every of them, from directly or indirectly making, using, or vending to others to be used, or in any manner counterfeiting or imitating the said invention or any part thereof, or any furnaces made in accordance therewith.

And also may it please your honors to grant unto your orators the writ of subpœna issuing out of and under the seal of this honorable court, directed to the said defendants, commanding them by a certain day and under a certain penalty to be and appear in this honorable court, then and there to answer the premises, and to stand to and abide such order and decree as may be made against them, and to grant to your orators such other and further relief as shall be agreeable to equity and to this honorable court shall seem fit.

And your orators will ever pray, etc.

CHARLES WILLIAM SIEMENS.
FREDERICK SIEMENS.

CHARLES S. WHITMAN,
SILAS W. PETTIT,
Solicitors for Complainants.

UNITED STATES OF AMERICA, }
State of Pennsylvania, } *ss:*

Before me, the subscriber, personally came H. B. Richmond, who, being duly sworn according to law, deposes and says that he is one of the firm of Richmond & Potts, who are the agents in the United States of the said Charles William Siemens and Frederick Siemens, for the sale of licenses under, *inter alia*, their letters patent of the United States in the above and foregoing bill mentioned; that
7 both said plaintiffs are out of the United States and in Europe, where they reside; that he has read the above and foregoing bill, and that the facts therein set forth are true so far as they are within his own personal knowledge, and that he verily believes the same to be true so far as they are stated upon his information derived from others.

H. B. RICHMOND.

Sworn to and subscribed to before me, this 28th day of Sept., A. D. 1880.

[SEAL.] SAMUEL BELL,
U. S. Commissioner.

(Endorsed:) 8 October sess., 1880, C. C. U. S. Siemens *et al. v.* Sellers *et al.* Bill in equity. Issue subpœna ret'ble 1st Monday of November, 1880. C. S. Whitman, Silas W. Pettit. Filed September 28, 1880.

8 And afterwards, to wit, on the 13th day of January, A. D. 1881, the defendants, by their solicitor, Henry Baldwin, Jr., Esq., come into our said court here and file their answer to the bill of complaint, in the words following, to wit:

United States Circuit Court, Eastern District of Pennsylvania. In Equity.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS vs. WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, Jr., JOSEPH F. TOBIAS, and JAMES A. WRIGHT.	No. 8. Oct. Sess., 1880.

The joint and several answer of William Sellers, Edward W. Clark, John Sellers, Jr., and James A. Wright, the defendants, to the bill of complaint of Charles William Siemens and Frederick Siemens, complainants.

These defendants, respectively now and at all times hereafter saving and reserving to themselves all and all manner of benefit or advantage of exception, or otherwise, that can or may be had or taken to the many errors, uncertainties, and imperfections in the said bill contained, for answer to said bill, or so much thereof as these defendants are advised it is material or necessary for them to make answer unto, severally and jointly answering, say:

I. We admit that letters patent of the United States, bearing date March 1st, 1864, issued to the above-named complainants for "improved regenerator furnace for metallurgists and others," but whether the said complainants were the original and first inventors

9 of the improvement patented in said letters patent, or whether the said improvement was known or used before the said alleged invention by said complainants, or whether it was in public use or on sale at the time of the application of said complainants for said letters patent, we do not know.

II. We admit that said letters patent granted to the complainants and bearing date March 1st, 1864, were surrendered and reissued on January 12th, 1869, but whether said original letters patent were surrendered because they were inoperative or invalid by reason of a defective or insufficient specification, which arose by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, we do not know.

We are not informed, and do not know, whether the said complainants put their said alleged invention on sale in the United States within eighteen months of March 1st, 1864, nor whether they have continued to keep it on sale since that time.

III. We deny, for the reasons hereinafter set forth, that the complainants will lawfully receive large gains from the sale and use of their said alleged invention if the alleged infringements by the defendants are prevented.

IV. We deny that we have, or that either of us has made, used, or sold furnaces embracing in their construction or mode of operation substantially the same invention patented in said reissued letters patent.

V. We believe that the Midvale Steel Works, a corporation organized under the laws of the State of Pennsylvania, and doing business in the city of Philadelphia, has since July 22d, 1878, used a furnace embodying substantially the construction and mode of operation specified and claimed in said reissued letters patent; and we admit that we have been directors of the said corporation since July 22d, 1878, but we are informed and believe that such user by such corporation, of which we have been as aforesaid directors, even if it constituted a violation by said corporation of the rights of the complainants in said letters patent, is not a violation of said rights for which we are or either of us is in any way liable or accountable.

VI. We aver that English Letters Patent No. 167, of 1861, dated January 22d, 1861, and sealed July 19th, 1861, were granted to Charles William Siemens and Frederick Siemens, the above-named complainants, for "Improvements in Furnaces," and that the said invention so patented by said letters patent is substantially the same invention patented in the reissued letters patents of the United States aforesaid, by reason whereof the said last-named letters patent, under the provisions of the statute in such case made and provided, are limited to the term of seventeen years from the date or publication of such English Letters Patent aforesaid; and we aver that by reason of such limitation the said reissued letters patent expired on or before the twenty-second day of July, 1878.

VII. We aver, on information, advice, and belief, that the subject-matter specified and claimed in the third claim of said reissued letters patent, is not lawfully patentable under the laws of the United States.

VIII. We are advised and believe that said reissued letters patent were and are null and void, because, contrary to the provisions of the statute in such case made and provided, they purport to be granted for a term of seventeen years from March 1st, 1864, and are not expressly limited to a term of seventeen years from the date or publication of the aforesaid English letters patent for the same invention.

IX. We deny that the making, using, or vending, since July 22d, 1878, of a furnace, embracing in its construction or mode of operation, the invention patented in the said reissued letters patent of the United States, is an infringement of any right of the complainants.

X. We deny that the Midvale Steel Works, the corporation aforesaid, has, or that we have, or that either of us has, since the 1st day of July, 1878, and before the 22d day of July, 1878, made, used, or sold a furnace embracing, in its construction or mode of operation, the invention, or any part of the invention, patented in said reissued letters patent of the United States, and we deny all, and all manner of, unlawful combination and confederacy wherewith we are by the said bill charged.

Without this, that any other matter, cause, or thing in the said complainants' said bill of complaint contained material or necessary for these defendants to make answer unto, and not herein and hereby well and sufficiently answered, traversed, confessed, and avoided or

denied, is true to the knowledge or belief of these defendants; all which matters and things these defendants are ready and willing to aver, maintain, and prove as this honorable court shall direct; and humbly pray to be hence dismissed, with their reasonable costs and charges in this behalf most wrongfully sustained.

WM. SELLERS.

11 STATE OF PENNSYLVANIA, } ss:
County of Philadelphia, }

William Sellers, having been duly affirmed, deposes and says: That he is one of the above named defendants; that he has read the foregoing answer and knows the contents thereof; that the matters and things set forth in said answer are true of his own knowledge, except such of them as are stated upon information and belief, and as to all such matters he believes them to be true; and further saith not.

WM. SELLERS.

Affirmed to and subscribed before me this 13th day of January, A. D. 1881.

[NOTARIAL SEAL.] CHARLES F. ZIEGLER,
Notary Public.

(Endorsed:) United States circuit court, eastern district of Penn'a. In equity. Charles William Siemens and Frederick Siemens *vs.* William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A Wright. No. 8. October sess., 1880. Answer. Filed January 13, 1881.

12 And afterwards, to wit, on the 20th day of January, A. D. 1881, the complainants, by their solicitors, came into our said court here and file their replication, in the words following, to wit:

U. S. C. C. Oct. Sess., 188.

CHARLES WILLIAM SIEMENS *et al.* }
vs. } No. 8.
WILLIAM SELLERS *et al.* }

The replication of Charles William Siemens and Frederick Siemens, plaintiffs, to the answer of William Sellers, Edward W. Clark, John Sellers, Jr., and James A. Wright, defendants:

These repliants, saving and reserving to themselves all and all manner of advantage of exception to the manifold insufficiencies of the said answer, for replication thereunto say: That they will aver and prove their said bill to be true, certain, and sufficient in the law to be answered, and that the said answer of the said defendants is uncertain, untrue, and insufficient to be replied unto by these repliants; without this, that any other matter or thing whatsoever in
13 the said answer contained material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, is true; all which matters and things these repliants are and will be

ready to aver and prove as this honorable court shall direct, and humbly pray as in and by their said bill they have already prayed.

CHARLES S. WHITMAN,
SILAS W. PETTIT,
For Plaintiffs.

(Endorsed:) 8. Oct. sess., 1880. U. S. C. C. In equity. Charles William Siemens *et al. vs.* William Sellers *et al.* Replication. Filed January 20, 1881. Charles S. Whitman, Silas W. Pettit.

14 *Depositions on behalf of Complainants.*

United States Circuit Court, Eastern District of Pennsylvania.
In Equity. October Sessions, 1880.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS
vs.
WILLIAM SELLERS, *et al.* } No. 8.

Evidence offered on behalf of complainants before Charles F. Ziegler, notary public for the Commonwealth of Pennsylvania, residing in the city of Philadelphia, special examiner, at the office of Baldwin, Hollingsworth & Fraley, No. 714 Walnut street, Philadelphia, on the twenty-eighth day of November, A. D. 1881, at 11 o'clock a. m.

Present: Silas W. Pettit, Esq., counsel for complainants; Henry Baldwin, jr., Esq., counsel for defendants.

It is stipulated and agreed between counsel for the respective parties in this cause that Charles F. Ziegler, notary public, shall act as special examiner herein, to take and return to the court
15 the testimony adduced on each side, and with the same effect as though he had been specially appointed examiner by the court; and at a meeting held this twenty-eighth day of November, A. D. 1881, pursuant to notice and agreement between counsel, Mr. Pettit appearing before the said examiner on the part of complainants, and Mr. Baldwin on the part of defendants—

Complainants offer in evidence complainants' letters patent reissue No. 3265, dated January 12th, 1869, to Charles William Siemens and Frederick Siemens, of Westminster, England, for improved regenerator furnace for metallurgists and others, being the reissued letters patent mentioned in the bill in this cause, and it is agreed that a certified copy may be substituted for the original in the record, and the same is marked "Exhibit Complainants' Reissue Letters Patent No. 3265, C. F. Z., Sp. Ex., Nov. 28, 1881."

And complainants rest.

Depositions of witnesses on behalf of plaintiffs in rebuttal taken, sworn to, and reduced to writing by and before Charles F. Zeigler, a notary public for the Commonwealth of Pennsylvania, residing in the city of Philadelphia, at the office of Messrs. Baldwin, Hollingsworth & Fraley, No. 714 Walnut street, Philadelphia, on Tuesday, November 21st, 1882, at 1 o'clock p. m., and pursuant to adjournment.

Present: Charles S. Whitman, Esq., and Silas W. Pettit, Esq., counsel for plaintiffs; Henry Baldwin, Jr., Esq., counsel for defendants.

It is agreed between counsel for the respective parties that "blue-book" copies of specifications and drawings of English letters patent shall be *prima facie* evidence of the fact of the granting of such letters patent and of the date and contents thereof without being certified by the Patent Office or otherwise formally proved with the same effect as if such copies were certified under section 893 of Revised Statutes.

Complainants offer in evidence under the above stipulation a "blue-book" copy of British letters patent No. 2861, dated
16 December 2d, 1856, to Frederick Siemens, and the same is marked "Complainants' Exhibit, Frederick Siemens' Patent of 1856, C. F. Z., Sp. Ex., Nov. 2d, 1882."

GEORGE R. WAITE, a witness on behalf of complainants, being first duly sworn according to law, in response to the interrogatories proposed by Mr. WHITMAN, deposes and says:

1 Question. What is your name, age, residence, and occupation?

Answer. George R. Waite; forty years of age; Philadelphia; mechanical engineer.

2 Question. How long have you been a mechanical engineer?

Answer. About twenty years.

3 Question. In the performance of your duties as a mechanical engineer have you become acquainted with furnaces, and particularly with furnaces used in metallurgical operations and in the manufacture of iron and steel?

Answer. I have.

4 Question. Please state the extent of your experience in the construction and use of furnaces, and furnaces made use of for metallurgical operations, and in the manufacture of iron and steel.

Answer. During the past fourteen years I have made a specialty of the Siemens furnace, and have been engaged in the designing, construction, and management of furnaces, and am familiar with the various processes to which they are applied.

5 Question. What are your qualifications, from your experience as a mechanical engineer, for understanding descriptions of mechanical devices and furnaces made use of in the manufacture of iron and steel, and for interpreting drawings illustrating mechanical devices and furnaces?

Answer. I have made drawings for the same, and have carried out drawings made by others.

6 Question. Has it been a part of your business to construct furnaces known as regenerative furnaces from drawings which have been furnished to you?

Answer. It has; and also from drawings made by myself.

7 Question. Please examine "Exhibit Complainants' Reissue Letters Patent No. 3265," and state whether you understand the specification and drawing of same.

17 Answer. I have examined that reissue and do understand the drawing and specification of same.

8 Question. Have you examined "Defendants' Exhibit, Complainants' English Patent of 1861," and do you understand the same?

Answer. I have examined and do understand the same.

9 Question. Please state whether a person skilled in the art of building furnaces would be able to construct from the specification and drawing of English patent 167, which you state you understand, a furnace capable of actual use for the purpose of manufacturing iron and steel, or for any purpose whatever.

Answer. He could not.

10 Question. Please give your reasons for your last answer.

Answer. First, an inadequate supply of air supplied for combustion; no means of regulating the amount of air and gas admitted to the furnace, and an imperfect mixture of same in combustion chamber; three separate reasons.

11 Question. Could a person skilled in the art of building furnaces, from the specification and drawing of English letters patent No. 167, construct a furnace built according to the specification and drawing of reissue letters patent 3265, the exhibit of the complainant in this case?

Answer. He could not.

12 Question. Please give your reasons for your last answer.

Answer. There are so many points of difference between the two. The system of supplying the air to the valves, the absence in English patent No. 167 of regulating valves, and the different manner in which the air and gas are brought together in the combustion chamber.

13 Question. Please point out what you understand to be the principal points of difference between the furnaces described in specification and drawing of English letters patent No. 167 and the furnace described in United States reissue No. 3265.

Answer. In the English Exhibit 167, in figure 3, the air is supplied to the valve *h* from the passage I, the air supplying I being received through the small passages *e* under bed of furnace, connecting at opposite sides of furnace with passage *f*, opening into the atmosphere. In the United States reissue 3265, on sheet 2, figure 6, is represented the air as being admitted to the valve R directly from the atmosphere or chamber D. In

18 the English Exhibit 167 the gas and air are represented as entering the furnace side by side. In the United States exhibit the air is represented as entering the furnace over the gas. In the English drawing 167 the regenerator bricks are shown and described as resting on gratings; in the American reissue 3265 they are shown as resting on arches or arched slices. In the English specification 167 the ventilating or cooling of the bed is performed by cold air passing underneath bed of furnace, and from thence, by means of the various passages, to the air regenerators; in the reissue United States 3265 the ventilation is accomplished by a single chamber or space opened to the atmosphere at each end, and connecting with chimneys plainly indicated on Sheet 4, Figures 1

and 2. The specification and drawing of English letters patent 167 show pockets or receptacles for the reception of impurities from the furnace; these are not shown in the United States patent 3265. There is a difference in the relative position of the regenerative chambers. In the English patent 167 the reversing valves are represented as rectangular, and working in a rectangular case; in the United States patent 3265 they are oval, and shown as working in a circular case. In the United States patent the damper cases are provided with regulating valves of the pattern usually known as mushroom valves. These valves are used to regulate the supply of air and gas to the furnace. I see no equivalent of these valves in the English patent.

14 Question. Would a furnace in which the gas and air enter the combustion chamber, as illustrated in Figure 11 of English patent No. 167, be capable of operation for the manufacture of iron and steel?

Answer. The heat evolved in a furnace with the construction, as shown, would not be sufficient for any metallurgical purpose requiring any considerable degree of heat.

15 Question. Please give your reasons for your last answer.

Answer. The air and gas entering the furnace would not be thoroughly mixed until after reaching the regenerative chamber; consequently considerable portion of unconsumed gas would pass through the furnace; the heat evolved by the mixture made in the furnace would not be sufficient for manufacture of iron and steel.

16 Question. Please state whether the gas and air upon entering the combustion chamber would be thoroughly intermixed in the furnace described and shown in the United States reissue letters patent 3265, and give your reasons for your answer.

Answer. It would be thoroughly mixed; the air rising above the gas would, by the difference in specific gravity, become thoroughly mixed.

17 Question. Please state whether the quantity of air and gas flowing into the generators is accurately regulated in the furnace described and shown in reissued letters patent No. 3265, and give your reasons for such answer as you may make.

Answer. It is. In sheet 3, No. 3265, figure 3, are shown regulating valves, marked x and Y, for air and gas respectively. By raising these valves the quantity of air and gas admitted is increased until full volumue, equaling the capacity of the damper chests, is received; by lowering, the quantity is diminished.

18 Question. Do you find any air and gas-regulating valves, such as those just described by you, described or shown in English letters patent 167 of 1861?

Answer. I do not. I find nothing.

19 Question. Could a furnace be practically used without such air and gas-regulating valves, or equivalents thereof, as described in United States reissued letters patent 3265? Please give your reasons for any answer that you may make?

Answer. It could not. It is quite necessary in metallurgical operations to have absolute command of the quantity as well as

quality of heat. Without these regulating valves, or their equivalents, this could not be accomplished.

20 Question. Do you find any furnace described or shown in English letters patent No. 167 of 1861 in which the air enters the combustion chamber above the gas, as in the furnace described in United States reissue letters patent 3265?

Answer. I do not.

21 Question. Please state what means are made use of in United States reissued letters patent 3265 for maintaining the bed of the furnace, as well as the arches, at a low temperature, and whether you find any such uses or equivalent means made use of in the furnaces described in English letters patent No. 167 of 1861.

Answer. In the United States patent 3265, sheet 3, figure 4, also sheet 4, figure 2, I find beneath the bed or bottom of the combustion chamber, a space marked C, opened at either end to the atmosphere, openings shown on sheet 2, figures 5 and 6; also sheet 3, figure 4, letter C. This space communicates with chimneys represented on sheet 3, figure 3; sheet 4, figures 1 and 2. The higher the temperature of the bed of the furnace the more active becomes the circulation of the air by reason of the hot air being rapidly drawn away by the chimneys. In the English patent 167, in sheet 1, figures 1, 3, and 8, are represented small passages marked *e*. In figure 3, sheet 1, a longitudinal section of these passages is shown. The air to these passages enters through *f*, and is carried away by I; the circulation, and consequently the cooling of the bottom of furnace and the top of the regenerator arches is dependent upon the amount of air used in the furnace for cumbustion.

22 Question. Please state the function of the air space or chamber D described and shown in United States reissued letters patent 3265, and state whether you find such an air space, or the equivalent thereof, in English letters patent 167 of 1861.

Answer. The air space D, shown on figure 3, sheet 3, of United States patent 3265, contains the damper case and supplies it directly with air. I do not find its equivalent in the English patent.

23 Question. Could a furnace of the construction shown and described in United States letters patent No. 3265 be used with but one regenerative chamber for any purpose?

Answer. There are purposes for which it might be useful. In a process during a certain portion of which a low heat is required and later a higher one, such a construction would be found useful

24 Question. Do you mean by your last answer that but one regenerative chamber could be used; and, if so, what means would be substituted for the other three regenerators?

Answer. That was my meaning. The three regenerators would be suppressed (two gas and one air), and in their place substitute passages. In the passage accompanying the remaining regenerative chamber should be placed a damper to close said passage while the chamber is being heated by the products of combustion.

25 Question. I understand you to say that the damper chests shown in the English patent are rectangular, while the damper chests in the American patent are circular; state

whether any advantage is obtained by constructing the dampers and damper chests of a circular form.

Answer. The rectangular damper chest is much more liable to become warped by heat, thereby leaking and allowing the gas to escape to the chimney instead of conveying it to the regenerative chamber. The circular form of damper chest is much to be preferred.

26 Question. If you find on examining United States reissued patent 3265 that the partition wall between the regenerative chambers and the partition wall separating the air and gas flues are in the same vertical plane, will you please state whether any advantage is obtained by such obstruction?

Answer. I find the walls referred to are in the same vertical plane. It allows a uniform distribution of the weight carried by the regenerator arches. It also allows the passages connecting the damper cases and regenerator chambers to be more nearly an equal length than in any other form of construction.

27 Question. Could the value marked W, figure 3, sheet 1, of English letters patent No. 167 of 1861, be used successfully to regulate the flow of gas to the generator? Please give your reasons for any answer you may make.

Answer. It could not. A workman in regulating the furnace should be able to see immediately the effects of any alteration in dampers or valves. The distance from the damper marked W to the furnace is so great as to prevent this. Should a smaller quantity of gas be required at the furnace and the damper W be closed, or nearly closed, there would cease to be an outward pressure of gas in the cooling tube, which if not perfectly tight would cause an inflow of air, producing a combustive mixture.

28 Question. In metallurgical operations and in the manufacture of iron and steel, what would be the effect upon the charge in the combustion chamber of admitting air and gas thereto by the means described and shown in English letters patent 167 of 1861?

Answer. The effect would be a considerable oxidation or burning of the metal.

29 Question. In metallurgical operations and in the manu-
22 facture of iron and steel, is it not necessary in order to prevent the oxidation of the charge in the combustion chamber that means should be provided for accurately regulating the inflow of gas and air into the combustion chamber?

Answer. It is of the greatest importance that such means should be provided.

Adjourned to Wednesday, November 22, 1882, at 11 a. m.

(Examination resumed Nov. 22d, at 11 o'clock a. m.)

Parties present as before.

30 Question. Please examine United States reissued letters patent 3265, the exhibit of the complainants in this case, and state what kind of a furnace is described and shown, and give your reasons for your answer.

Answer. The furnace shown in United States patent is described as a puddling furnace, and has the general form of one. The top of the bed of the furnace is represented as being below the door or foreplate, thereby forming a receptacle or bed capable of containing molten metal. The furnace represented has a very shallow bed.

31 Question. Having reference to English letters patent 167, of 1861, are the channels N and O, through which cinders and other impurities are removed from the furnace as there described, necessary in a puddling furnace such as described and shown in reissued letters patent No. 3265? Please give your reasons for any answer that you may make to this question.

Answer. Not at all necessary. The object of the channels O and N shown in the English patent 167, sheet 2, figure 2, is to receive any deposits which may be carried over by the flame from the combustion chamber; also to receive any pieces of cinder or other impurity removed from furnace-bed by means of rabble or hook. The distance traveled by the flame is so short in its passage over these openings or channels that the deposit from the flame would be so exceedingly small as to amount to little or nothing. The particles removed by means of the rabble could be taken out of the door.

23 32 Question. Having reference to United States reissued letters patent No. 3265, please state whether or not the bed or hearth of the furnace is on a level with the bottom of the door opening?

Answer. The bed of the furnace is below the door opening; the bed of the furnace is described in the specification lettered *a;* in sheet 4, figure 2, the letter is in its correct place; in sheet 3, figure 3, the letter is above the bed.

33 Question. State whether in United States reissued letters patent No. 3265 there is sufficient in the specification and drawings to enable a party of ordinary skill in building furnaces to construct a furnace in which air passes upwards from a cooling chamber C through chimneys, the top of which is shown in plan in figure 1 and by dotted lines in figures 2 and 3?

Answer. There is.

34 Question. Please state whether in United States reissued letters patent No. 3265 and in the specification and drawing thereof there is sufficient to enable a party of ordinary skill in the construction of furnaces to construct a furnace in which there is a cooling chamber beneath the bed of the furnace, all the parts of which communicate with each other in such a manner as to allow the air to pass freely around and about the furnace-bed?

Answer. There is.

35 Question. Please examine United States reissued letters patent No. 3265 and if you find the gas-regenerative chambers between the air-regenerative chambers, please state if there is any advantage in such construction?

Answer. In the United States patent the gas-regenerative chambers are represented between the air; this allows the air to be conducted in its passage to the combustion chamber back of the gas

and at the point of mixture over the gas, thereby making a very intimate mixture.

36 Question. If upon examination of reissued letters patent No. 3265 you find the crown of the furnace above the entrance to the air-flues at a higher level than the crown of the furnace above the gas-flues, will you state what is the object attained by such construction?

Answer. The construction as described is shown; the object
24 is by leading the air down the incline to cause a more intimate mixture.

37 Question. If you find upon examination of reissued letters patents No. 3265 that there is a single air-chamber below the bed of the furnace, and upon investigating English letters patent 167 of 1861 you find that there are three or more chambers below the bed of the furnace, will you please state whether the construction described and shown in United States patent possesses any advantages over the drawing in the English patent?

Answer. The United States patent with its one chamber for cooling purposes allows a much freer circulation, and exposes a larger surface of the bed to the action of the cold air.

Cross-examined by Mr. BALDWIN:

X 38 Question. You give your occupation as mechanical engineer. During your twenty years in that occupation, how long have you known of the Siemens regenerative system?

Answer. Between fourteen and fifteen years.

X 39 Question. When, where, and in what connection did you first have knowledge of it, or become acquainted with it?

Answer. The first intimate knowledge I had of it was upon entering the services of Messrs. Tuttle, Gaffield & Co., in 1868. Previous to that time I had seen newspaper notices.

X 40 Question. Before 1868 did you know anything of it, except what you had seen in such notices?

Answer. No, sir.

X 41 Question. In 1868, what did you learn about it under the circumstances you have mentioned?

Answer. A short portion of 1868 I prepared drawings of furnaces, and began superintending the erection of a heating furnace at Messrs. Washburn & Moen's mills, at Worcester.

X 42 Question. Up to that time had you seen any such apparatus in operation?

Answer. Not at the time of beginning the drawings.

X 43 Question. What time in 1868 did you begin those drawings?

Answer. I think it was in October.

X 44 Question. What kind of work were the drawings intended for?

Answer. My recollection is that they were for heating furnaces.

25 X 45 Question. For heating what?

Answer. For heating iron.

X 46 Question. From whom did you get your instructions?

Answer. From the mechanical head of the house.

X 47 Question. Did he give you any specification or drawing to go by?

Answer. I don't remember. He must have given me specifications or sketches for the first furnaces.

X 48 Question. In connection with those drawings or instructions did you resort to any patent giving a description or representation of the Siemens system?

Answer. I don't remember.

X 49 Question. Did Tuttle, Gaffield & Co. erect the furnaces you designed?

Answer. I don't remember whether the furnaces for which the drawings were made were built or not.

X 50 Question. How long did you remain with them?

Answer. I remained until the style of the firm was changed. I don't remember the date when it was changed. It would be mere guess-work. I think it was about two years.

X 51 Question. Up to that time can you recollect whether or not they had built those furnaces?

Answer. No, sir; I can't recollect whether they had or had not. My impression, however, is that those furnaces were not built at that time.

X 52 Question. Where was this firm located?

Answer. In Boston.

X 53 Question. What was the new name when the style changed?

Answer. Richmond, Potts & Loring.

X 54 Question. Did you remain with that firm?

Answer. I did.

X 55 Question. Did you design any furnace or apparatus for using the Siemens system while you were with them?

Answer. The larger portion of the time while with them I was engaged in superintending the erection of furnaces.

X 56 Question. On this system?

Answer. On this system.

X 57 Question. Did they use such furnaces?

Answer. They were not manufacturers, but had a model furnace in their office—a working model.

26 X 58 Question. Did you draw a plan for that working model?

Answer. Yes, sir.

X 59 Question. How long did you remain with them?

Answer. Until the style of that firm changed again.

X 60 Question. How long was that?

Answer. I think the style of that firm changed in 1873.

X 61 Question. What was the new style?

Answer. Richmond & Potts.

X 62 Question. Were they manufacturers, and did they use furnaces?

Answer. They were not manufacturers, and they did not use furnaces.

X 63 Question. Were Tuttle, Gaffield & Co. manufacturers, or did they use furnaces?

Answer. They were not manufacturers, nor did they use furnaces.

X 64 Question. How long did you remain with Richmond & Potts?

Answer. Up to the present time.

X 65 Question. Are you still with them?

Answer. I am.

X 66 Question. What business were these gentlemen, under the different styles you have mentioned, engaged in?

Answer. They were the United States agents for the Siemens system.

X 67 Question. What was your function in connection with their business during the whole period and up to date?

Answer. That of engineer.

X 68 Question. Well, what did that involve in the conduct of the business and your relation to it?

Answer. The making of drawings, superintending the erection, starting, and managing those furnaces.

X 69 Question. For whom were the drawings made?

Answer. For various parties requiring the use of the furnace.

X 70 Question. For whom did you erect furnaces?

Answer. For various parties in different sections of the country.

X 71 Question. For whom did you manage furnaces?

Answer. For the same parties.

27 X 72 Question. Were all these parties licensees under the Siemens patent?

Answer. I had every reason to think so.

X 73 Question. How long have you managed any particular one of these furnaces after it was built?

Answer. About two months.

X 74 Question. Was it necessary for Richmond & Potts to have you do this for their licensees?

Answer. In many instances, yes.

X 75 Question. Did the management involve something more than the ordinary hand about a furnace would understand?

Answer it did.

X 76 Question. Was it not part of your management to instruct such hands how to manage such furnaces?

Answer. It was.

X 77 Question. What were the particular points of difficulty requiring such instruction?

Answer. The instruction consisted in teaching the men at the producers to make the gas, the men at the furnace to regulate the furnace in such a manner as to give the desired heat and to prevent oxidation in the furnace, the men in many instances never having seen the Siemens furnace or producers.

X 78 Question. What was involved in this regulation of the furnace?

Answer. The entire success of the furnace.

X 79 Question. How was it regulated?

Answer. By means of valves for the admission of air and gas, chimney damper, and by the reversing valves.

X 80 Question. When did you first examine a Siemens patent on such apparatus as has been referred to, and which of their patents was it?

Answer. Copies of the various patents have been in the office of the different firms having the agency, and from time to time I have looked at them; but the first examination of any particular patent was about two years since—the English patent No. 167 and the American reissue 3265.

X 81 Question. Prior to that time, then, you had not made any special examination of any of the Siemens patents, English or American?

28 Answer. Prior to that I had made no such special examination.

X 82 Question. During this period, while you were with the different firms mentioned, then you have been planning, erecting, and managing furnaces on the Siemens system, without any special reference to or study of their patents up to two years ago, have you?

Answer. Up to two years ago I paid no particular attention to the study of the Siemens patents.

X 83 Question. Was not the examination, about two years ago, of the English patent 167, and of the reissue 3265, made in connection with this controversy?

Answer. At the time when I made the examination, about two years ago, I knew nothing of this controversy.

X 84 Question. Don't you know now that that examination was made with reference to or in connection with this controversy?

Answer. I presume it was.

X 85 Question. Don't you know or believe that it was?

Answer. Yes; I think it was in view of this controversy.

(Adjourned to 2:45 p. m.)

(Examination resumed at 2:45 p. m.)

X 86 Question. During the time you have been planning, erecting, or managing Siemens furnaces, under either of the firms mentioned, have you ever been guided or governed, so far as you know, by anything contained in any one of the Siemens patents, English or American; and, if yea, in which of them?

Answer. In the designing and managing of the furnaces, I have not paid particular attention to any special patent. In the erection of the furnaces, the drawings, as furnished, were followed.

X 87 Question. Have you, in any of your designs of such furnaces, derived any detail of the construction immediately from any of the Siemens patents; and, if yea, from which of them?

Answer. I have not.

X 88 Question. Please state the range of application to

29 different purposes within which you have designed, erected, or managed such furnaces, as you have mentioned?

Answer. Annealing furnaces, heating furnaces, puddling furnaces, furnaces for the manufacture of steel, furnaces for the manufacture

of glass, furnaces for the manufacture of zinc, and chemical furnaces.

X 89 Question. Have you ever designed, erected, or managed, under either of the firms you have mentioned, or for anybody, during your connection with those firms respectively, any furnace the details of which you find represented identically in the drawings annexed to the reissue 3265?

Answer. I have not.

X 90 Question. In your later practice in planning, erecting, or managing Siemens furnaces, have you not dispensed with chimneys?

Answer. In some styles of furnaces chimneys are still used.

X 91 Question. In what style do you retain the chimneys?

Answer. Steel pot furnaces, certain types of heating furnaces, glass furnaces, puddling furnaces.

X 92 Question. Then in some styles of heating furnaces you dispense with chimneys?

Answer. Yes.

X 93 Question. Since when have you dispensed with the chimney in any style of these furnaces?

Answer. The chimney is dispensed with in those furnaces wherein the casing or binding plates do not extend below the bottom bed of furnace.

X 94 Question. When did you first plan one of these furnaces dispensing with a chimney?

(Objected to as not cross-examination.)

Answer. I think that the first one that I drew, not showing the chimney, was some time in the year 1878.

X 95 Question. What did you substitute, or how did you compensate for the chimney thus dispensed with?

(Same objection.)

Answer. By making the distance from underneath side of bed to top of regenerator arches greater, leaving the sides and bottom of bed entirely open to the atmosphere; in other words, by putting no casing or binding plates below the bottom of bed to prevent the free circulation of the air. The space also between the side plates of bottom and wall of posts was increased.

X 96 Question. Do you find such construction described or shown in the reissue 3265?

Answer. No, sir.

X 97 Question. Do you find such construction indicated in the reissue 3265?

Answer. No, sir.

X 98 Question. You say you have read and understand the drawing and specification of the reissue 3265, and also that you have examined and understand the English patent 167 of 1861. Have you carefully compared the specifications of those patents with each other?

Answer. I have.

X 99 Question. Aside from the literal description referring to the

drawing, do you say now that the two specifications are substantially different from each other?

Answer. Yes, sir.

X 100 Question. Point out the differences, referring, if you please, for convenience of comparison, to the pages and folios of specifications as published in the defendants' record, omitting reference in the English patent to the literal description on page 113, commencing at folio 447 and extending down to the fifth line from the bottom of that page, and any other reference to the drawing and in the reissued patent, excluding all references to the drawing.

(Adjourned to Thursday, November 23d, 1882, at 11 o'clock a. m.)

(Examination resumed on Thursday, November 23d, 1882, at 11 a. m.)

Parties present as before.

(X 98 question is objected to as indefinite. It calls for an answer which will be necessarily unintelligible, as, under the statutes of the United States, the drawings are a part of the specification, and the most important part. In this instance the specification of the United States patent would be unintelligible unless read in connection with the drawing forming part thereof.)

31 Defendants' counsel, inasmuch as this objection is interposed only after such an interval as has elapsed since the adjournment yesterday, and foreshadows the probable answer of the witness, withdraws the question.

X 101 Question. In answer to question 30 direct, you say that furnace shown in United States patent 3265 is described as a puddling furnace and has the general form of one. Is it not described in the patent as "a puddling furnace, with our said invention applied to it"?

Answer. That is the wording in the specification.

X 102 Question. In the English patent 167, of 1861, do you not find the inventors say, "In figures 11, 12, and 13 is shown a construction of our improved regenerative gas furnace, adapted for the purpose of puddling iron"?

Answer. It is so expressed.

X 103 Question. Do you not find, in the American patent, that the specification says that the Messrs. Siemens have made "a new and useful invention having reference to furnaces of various kinds"?

Answer. I find that clause as quoted.

X 104 Question. Does not the English patent 167 state, "that these improvements relate to that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion and to communicate the same, subsequently, to the air-supporting combustion"?

Answer. Yes.

X 105 Question. Do you understand, from these parts of the patents 3265 and 167, respectively, that the improvement covered by the specifications, respectively, is in the construction of a puddling

furnace, or of any other particular style of furnace, or do you understand that the improvement relates to the application of the regenerative system to furnaces of different kinds and styles for different purposes?

Answer. The English patent 167, I understand the improvement to relate to that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion and to communicate the same, subsequently, to the air-supporting combustion. The American patent No. 3265, I understand to be an invention applied to various furnaces, and not confined specially to a puddling furnace.

X 106 Question. Do you find any difference in the princi-
32 ples or applications of the regenerative system described in the two patents? And, if yea, point it out.

(Answer objected to as indefinite as to the words "regenerative system.")

(Question withdrawn.)

X 107 Question. You state, in answer to question 9 direct, that a person skilled in the art of building furnaces could not construct from a specification and drawing of English patent 167 a furnace capable of actual use for the purpose of manufacturing iron and steel, or for any purpose whatever, and you give three separate reasons; first, an inadequate supply of air supplied for combustion. Do you now say that none of the illustrations shown in the drawings of the English patent provide for an adequate supply of air for the operation of any furnace whatever?

Answer. In the English patent I see no drawing in which the air supplied to the furnace is of sufficient quantity to perform the work required of that furnace.

X 108 Question. How do you get at that conclusion?

Answer. The English patent, sheet 1, figure 3, represents the only furnace, or view of furnace, in which the air valve and its supply chamber, with its passages, is shown. In this view the passages are too small for the proper supply of the air required by the furnace.

X 109 Question. In saying that, do you assume the drawing which you refer to to be made to a scale?

Answer. I suppose it to be. I take it to be made to a scale, or very nearly to a scale.

X 110 Question. Do you base your conclusion as to the insufficiency of the supply that the drawing is made to a scale?

Answer. I base it upon that, and also upon the relative size of the flues and passages for the admission of the gas, as shown on the figure referred to.

X 111 Question. Upon that assumption, how do you determine your opinion that the air supply is insufficient?

Answer. With the means I have at my command to measure the size of these openings, marked *e*, through which the air has to pass before entering the valve; their total area, as compared with the area of the valve, is a trifle over one-fourth.

33 X 112 Question. What should the area be for practical working?

Answer. In a furnace where the air is heated, before reaching the valve, it is impossible to estimate the proper area of the valve without first knowing the temperature of the air to be admitted.

X 113 Question. Who is to make that estimate in constructing a furnace for any purpose whatsoever?

Answer. That estimate could not be made accurately by any one without first knowing the temperature of the air to be supplied at the valve.

X 114 Question. Who would make it, knowing that essential fact?

Answer. That would fall to the lot of the one designing the furnace.

X 115 Question. Then it would come, for example, within your province as an engineer, would it?

Answer. Were I enaged to make drawings for furnaces, as represented in figure 3 of sheet 1, English patent, it would.

X 116 Question. Would this area be increased or diminished according to the increased temperature of the air in any given instance?

Answer. Air, on being heated, increases in volume.

X 117 Question. Then the higher the temperature of the air the greater the area of these passages should be, is that what you mean?

Answer. It is.

X 118 Question. Have you given your opinion as to the insufficiency of this supply of air to the chamber I, upon the assumption that air enters that chamber only through the passages *e* in figure 3?

Answer. I see no other means by which the air enters this chamber I, except through passages *e*.

X 119 Question. Do you assume that there are no other means?

Answer. I do.

X 120 Question. Do you find in the English patent another instance where the passages, corresponding to *e* in figure 3, have a much larger area than those in that figure?

Answer. On sheet 2, English patent 167, figure 11, the passages marked *a'* have a larger area.

34 X 121 Question. Do you find in the English patent 167 any restriction upon the skill of the constructor or the judgment of the engineer which confines him to such an area for the passages *e*, or for the supply of air to the chamber I as would instruct him to make that area or that supply inadequate?

Answer. Only as far as those areas are shown in the drawings to be inadequate.

X 122 Question. Do you find in the American patent anything relating to the regulation of this supply or the provision for it according to the temperature of the air?

Answer. In the American patent the air is taken in by the valve directly from the atmosphere or space D, and is therefore of normal temperature.

X 123 Question. Repeated.

(Adjourned to 2 p. m).

(Examination resumed at 2 p. m.)

Answer. I see nothing relating to the temperature of the air to be admitted to the valve in the specification.

X 124 Question. What do you find in the specification of 3265 about the regulation of the supply of air?

Answer. On page 67 of defendants' record, the folio 264, I quote: "The valve Y will serve to arrest the flowage of air into the passage F, so with the valve X it will answer to close off the passage of gas into the damper case immediately underneath it."

X 125 Question. Do you not find similar statements in the English specification No. 167 as to the regulation of the air and gas by valves and dampers?

Answer. In the English specification I find on page 6 and the second line: "The currents of heated gas and air in ascending from and through the regenerators into the furnace, causing a plenum of pressure within the same, which is capable of being modified or regulated by valves for the admission of the gas and air to the regenerators and by the chimney damper; by the same arrangements the chemical qualities, as well as the intensity of the flame, can be regulated to the utmost nicety." These valves or their equivalents are not shown in the English drawings, unless it is considered that the reversing valves or dampers are used for regulating the supply of gas and air to the furnace. It is not practicable to use these valves for this purpose.

X 126 Question. Do you not find in the provisional specification of the English patent 167 a further statement of the dampers for regulating the quantity and quality of the flame and the location of these dampers in the cold air and gas channels?

Answer. In the English provisional specification, page 2, folio 35, I find the following sentence: "Dampers are provided in the cold air and gas channels by which the quantity and quality of the flame can be regulated to the utmost nicety."

X 127 Question. Now, in view of these facts, do you still hold to the opinion that one skilled in the art and skill of building furnaces could not construct, from the specification and drawings of English patent 167, a furnace capable of actual use for the purpose of manufacturing iron and steel, or for any purpose whatever, by reason of the absence of an adequate supply of air for combustion, or of provision for such supply, or by reason of the absence of any instructions as to such supply and its regulation?

Answer. I still hold to that opinion.

X 128 Question. How far does that opinion extend as to the kind of furnaces, in the art of building which you suppose the person referred to to be skilled—I mean does it include persons skilled in the art of building furnaces where regenerators are applied to receive the waste heat of the products of combustion, and to communicate the same subsequently to the air supporting combustion?

Answer. I do not think a person skilled in the art of building that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion, and to communicate the same

subsequently to the air supporting combustion, could build a furnace from the drawings and specifications of English patent 167 which could be used practically for any metallurgical purpose.

X 129 Question. Does not the English patent 167 contain sufficient direction as to the supply of air about which we have been talking, and the regulation thereof, to enable a person skilled in the
36 art of building such furnaces to adapt the supply of air to the requirements of one particular style of furnace or another?

Answer. I find nothing in the English patent 167 which would enable such an one to make satisfactory provisions for the air required in any furnace.

X 130 Question. You say the supply afforded by the channels *e*, figure 3, of the English patent would be inadequate, do you?

Answer. Yes, sir; inadequate and irregular.

X 131 Question. How do you know that?

Answer. By experience. Experience teaches me that.

X 132 Question. If an additional supply was brought into the chamber I from another source, would that supplemental supply compensate for the inadequacy of that derived from the channels *e*, as you view them?

Answer. It would depend upon the amount of air thus brought in.

X 133 Question. If the channels *e* of figure 3 in the English patent were enlarged to an area such as is shown by the passages *a* in figure 11, sheet 2, would such enlargement compensate in any degree for the inadequacy of the channels *e* in figure 3?

Answer. It would to a certain degree, but the supply of air to the valve *h* would be irregular; the supply would depend greatly upon the heat or temperature of the air passing through this channel.

X 134 Question. Now, assume the channels *e*, in figure 3, to be enlarged so as to admit a sufficient supply of air, would the furnace be capable of actual use for any purpose whatever?

Answer. If the passages *e* were increased the furnace would be irregular in its action, and in the furnace shown in figure 3 the bottom of furnace would be so chilled as to prevent satisfactory working.

X 135 Question. Well, the supply of air would no longer be necessarily inadequate, would it?

Answer. The passages referred to might be increased to such an extent that the supply would not be inadequate, but that would necessitate a different construction of furnace from that shown.

X 136 Question. Now, you say in answer 10 direct that
37 in the English patent 167 there are no means of regulating the amount of air and gas admitted to the furnace; do you mean to make that statement broadly?

Answer. The air and gas-reversing valves, were it not for certain mechanical difficulties, might be used for such a purpose, but I can see no practical way shown in English patent 167 of regulating either air or gas.

X 137 Question. You say "shown;" does not the English patent state that dampers are provided in the cold air and gas channels by

which the quantity and quality of the flame can be regulated to the utmost nicety, and, again, that the pressure within the furnace is capable of being modified or regulated by valves for the admission of gas and air to the regenerators, and by the chimney damper, and do not these statements in the specification point out the means and the location of the means for regulating the amount of air and gas admitted to the furnace?

Answer. In the English patent 167, provisional specification, dampers are spoken of as being provided in air and gas channels by which the quantity and quality of the flame may be regulated. The location of those dampers is not shown, unless the reversing valves are meant. The reversing valves are spoken of as valves or dampers. The specification speaks of pressure being caused within the furnace capable of being modified or regulated by valves for the admission of air and gas to the regenerators, and by the chimney damper. This pressure in the furnace can be regulated by the chimney damper without the use of regulating valves.

X 138 Question. Have you so far testified under instructions or upon the understanding that the specification of a patent is governed by the drawings annexed to and forming part thereof?

(Objected to as not cross-examination, and also indefinite as to the word "governed.")

Answer. My understanding is that the drawings are used in showing the details and explaining the meaning of the specification.

X 139 Question. You say you understand the English patent 167. Do you understand the general description to be restricted or confined or limited to the particular details of construction shown in the drawings and referred to in the specification?

38

Answer. I do not think I understand your question.

X 140 Question. You say you understand this English patent 167; how do you understand it, as a general description of the invention, its principles and mode of operation, with particular illustrations of its application, or do you understand it as giving only particulars and illustrations of all that is involved in the application to use of the improvement or invention set out?

Answer. I understand it as a description of the invention, and the means best known at that time of carrying out that invention.

X 141 Question. Do you understand that in this patent 167 the reversing valves could regulate the quantity of air and gas admitted to the furnace?

Answer. Not satisfactorily.

X 142 Question. As one skilled in the art of building such furnaces, would you not understand from the specification that they were not intended to be used for that purpose?

Answer. Considering the amount of skill and knowledge of these furnaces at the time when the patent was issued, I should say that it was the intention to use the regulating valves or dampers for that purpose. At the present state of the art I would say it was impossible to so use them.

X 143 Question. You give as your third reason why a person skilled in the art could not build a furnace capable of actual use for any purpose from the specification and drawing of English patent 167, "an imperfect mixture of same (air and gas) in combustion chamber;" do you mean because they enter side by side, as you have elsewhere stated they do?

Answer. That is the reason.

X 144 Question. Do you mean anything more as to that than that the mixture is more perfect when the air enters above the gas?

Answer. The mixture is much more perfect when the air enters over the gas than when currents enter side by side, as shown in the English patent, sheet 2, figure 12; in this instance the gas and air, entering side by side, are drawn through the furnace to a great extent side by side; the mixture not being perfect except at point
39 of contact, unconsumed gas will pass through the furnace and ports, free oxygen will enter on the other side, pass in the same manner; the effect of this mixture is a loss of heat and great oxidation or waste of the charge.

X 145 Puestion. Do you say that this mixture, wherever the gas and air enter side by side, is so imperfect as to defeat the operation of the furnace for any purpose, or do mean that it affects the perfection of its operation?

Answer. This mixture would defeat a satisfactory operation of the furnace for any purpose.

X 146 Question. You say a person skilled in the art of building furnaces could not, from the specification and drawing of English patent 167, construct a furnace built according to the specification and drawing of reissued letters patent 3265; now, from the specification and drawing of English patent 167, could a person skilled in the art construct furnaces of various kinds?

Answer. They could construct furnaces of various kinds from specification and drawing of English patent 167.

X 147 Question. Could he, from said English patent, construct a furnace having in combination therewith a chimney or smoke-discharge flue, a system or series of air and gas regenerators, and having conduits or dampers arranged so that air and gas may be led into and through such regenerators and furnace, and out of the chimney?

Answer. From the English patent 167 he could not construct a furnace as shown in the American patent 3265.

X 148 Question. Repeated.

Answer. He could build a furnace from English patent 167, such as you describe.

(Adjourned to Friday, November 24th, 1882, at 10 o'clock.)

(Examination resumed, Friday, November 24th, 1882, at 10 o'clock, a. m.)

Parties present as before.

X 149 Question. Point out in the reissued patent 3265, anything

in the specification that instructs you how to apportion the supply of the air to support combustion?

(Objected to as not cross-examination.)

40 Answer. The specification does not give any proportions for the air to be admitted.

X 150 Question. Point out any means of regulating the amount of the air and gas admitted to the furnace described in the reissued patent 3255?

Answer. In the reissue 3265 I find: "The valve Y will serve to arrest the flowage of air into the passage F, so with the valve X it it will answer to close off the passage of gas into the damper case immediately underneath it."

X 151 Question. Is that all?

Answer. Further, I quote: "Having conduits and dampers arranged so that air and gas may be let into and through such regenerators and furnace, and out of the chimney in manner, and so as to be operated as and for the purposes hereinbefore described."

X 152 Question. From what part of the specification is the last quotation made?

Answer. Page 3, nearly the bottom of the page. Quotation begins in eleventh line from bottom, second column.

X 153 Question. A part of first claim, is it not?

Answer. Yes, sir.

X 154 Question. What do you find in the reissue 3265 describing that the air and gas shall enter the latter below the former, and not side by side?

Answer. The same quotation as the last, from first claim.

X 155 Question. Is that all?

Answer. In connection with the drawings, sheet 4, figure 2.

X 156 Question. Point out, in the reissue 3265, any reference to the arches, or arched slices, on which the regenerator bricks rest?

Answer. On page 3, first column, I quote: "And having the grating extending across its lower part, and constituting part of the upper portion of an arched passage, H, I, K, or L, arranged underneath such chamber."

X 157 Question. In your opinion, is there any substantial difference in the operation of the reversing valves when they are rectangular and when they are oval?

Answer. No difference so long as each fits closely to its seat. The rectangular valve is more liable to warp out of shape.

X 158 Question. In the English patent 167, does figure 11
41 purport to represent a furnace for the manufacture of iron and steel?

Answer. It purports to manufacture a certain grade of iron, generally known as muck or puddled iron.

X 159 Question. Would you say that the furnace shown in figure 3 of reissue 3265 would properly be termed a puddling furnace?

Answer. It represents a puddling furnace, with an extremely shallow bed.

X 160 Question. Well, would you say it was suitable for a puddling furnace as represented in the reissue?

Answer. The bed, as represented, is more shallow than the furnaces generally used for such purpose, but it would be called a puddling furnace.

X 161 Question. Could it be used for practical work in puddling iron?

Answer. It could be used; but it would not be desirable to work with so challow a bed.

X 162 Question. You say, in answer to question 22, that you find no equivalent in the English patent 167 of the air-space D, which contains the damper case and supplies it directly with air; do you mean that you don't find any damper case in the English patent, or only that you don't find such damper case in the space D of the reissue?

Answer. My meaning was that I saw no equivalent in the English patent of the space D in the American patent.

X 163 Question. Don't you find in the English patent 167 a space in which there is a damper?

Answer. In figure 3, sheet 1, English patent, I find passage marked I opening into the damper case.

X 164 Question. Don't you find another space, and in it a damper case at large, D, figure 11, sheet 2, of the English patent?

Answer. I do.

X 165 Question. Is not air supplied to that damper case in figure 3 and in figure 11 also?

Answer. No, sir.

X 166 Question. What are those damper cases for?

Answer. In figure 3 the damper case marked H receives the air; in figure 11 the damper case marked D receives the gas.

42 X 167 Question. Well, then, in figure 3 is not the damper case for the same purpose as that in the space D of the American patent?

Answer. The damper cases are for the same purpose.

X 168 Question. Point out, in the reissue 3265, any and every word that indicates or suggests the use of a furnace of the construction shown and described therein, or of any furnace referred to therein, with but one regenerative chamber.

Answer. The last claim of the patent I quote: "We also claim the combination of a furnace with one or more regenerators, or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom, and also which means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas during its passage into or to such furnace, for the purpose of improving or promoting combustion therein."

X 169 Question. Is not that the only place in the patent where you find an illusion to the use of one regenerator?

Answer. It is.

X 170 Question. Do you say that the suppression of three of the four regenerators shown or described in the reissue 3265, and the

change of the construction and operation incident thereto, would be within the skill of the constructor?

Answer. Yes, sir.

X 171 Question. Would you say that it involved less knowledge or experience on the part of the constructor and designer to operate the furnace described and shown in the reissue 3265, with one regenerator, than it would be to enlarge the passage *e* of the English patent, so as to give an adequate supply of air for combustion?

Answer. I think it would.

X 172 Question. Do you think it would involve less skill and knowledge on the part of the constructor or designer to change the system shown in reissue 3265 to one regenerator than it would to regulate the supply of air and gas admitted to the furnace in the English patent?

Answer. I do.

X 173 Question. Do you think it would require less skill and experience on the part of the constructor and designer to change
43 the system shown in the reissue 3265 to one regenerator than to bring the air in above the gas, as in the reissue, instead of side by side, as in the English patent?

Answer. It would be easier to change and require less skill on the part of the constructor or designer to change to the one regenerator in the American patent than to arrange for bringing the air in over the gas in the English.

X 174 Question. You say in making the change in the American patent you would suppress two gas and one air regenerators and in their place substitute passages, and in the passage should be placed a damper; what would you do with the other three regenerators in this case?

Answer. I would substitute passages in the same manner as suggested in the patent 3265 in speaking of two regenerators being used.

X 175 Question. Would you tear down the suppressed regenerator?

Answer. In constructing such a furnace I should not erect the three regenerators.

X 176 Question. Did you ever construct such a furnace or design one?

Answer. No, sir.

X 177 Question. In your opinion does it involve invention, or did it involve invention in 1861, 1864, or 1868 to substitute oval or circular damper chests for rectangular ones?

Answer. As much so as the rectangular one, both being adaptations to this special use of the four-way valve.

X 178 Question. Don't these dampers and damper chests operate in the same way, whether they are rectangular or oval or circular?

Answer. Yes, sir.

X 179 Question. What does the reissue 3265 say about these damper chests as prescribing any particular shape for them?

Answer. Sheet 3, figure 3, represents them as having oval dampers, consequently the cases must be of circular shape.

X 180 Question. Does the specification say anything about the shape?

Answer. The specifications say nothing of the shape of the damper, except to refer to the ones shown in drawings, which are circular.

X 181 Question. What do you find in the specification of
44 the reissue 3265 as to the partition walls between the regenerative chambers and the partition walls separating the air and gas flues, being in the same vertical plane?

Answer. I find on page 3 in the first claim: "We claim in combination with furnace A, its chimney or smoke discharge flue P, a system or series of air and gas regenerators, B^1, B^2, B^3, B^4, constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be let into and through such regenerators and furnace and out of the chimney, in manner and so as to be operated in the manner and for the purpose as herein described." In sheet 4, figure 2, this construction is shown.

X 182 Question. You have said you understand this reissue 3265; have you given your deposition so far upon the understanding that the quotation you last made from this patent refers to such details of construction as the location of the partition walls in the same vertical plane?

Answer. Yes, sir.

GEO. R. WAITE.

(Adjourned to 2 o'clock p. m.)

(Examination resumed at 2.15 p. m.)

Sworn and subscribed to before me this 24th day of November, 1882.

CHARLES F. ZIEGLER,
Notary Public.

(Adjourned to Saturday, November 25th, 1882, at 10 a. m.)

(Examination resumed Saturday, November 25th, 1882, at 10 a. m.)

Parties present as before.

PARK BENJAMIN, a witness on behalf of the plaintiffs, being duly sworn according to law, in response to the interrogatories proposed by Mr. WHITMAN, deposes and says as follows:

45 1 Question. What is your name, age, residence, and occupation?

Answer. Park Benjamin; thirty-three; Montclair, New Jersey; doing business in New York city; mechanical engineer and scientific expert.

2 Question. Please state to what extent you are familiar with the arts and sciences, with manufacture of iron and steel, and with letters patent for inventions relating thereto, and whether you have heretofore testified as an expert in patent causes.

Answer. I am a graduate of the United States Naval Academy; was for six years associate editor of the Scientific American, and am the chief editor of Appleton's Encyclopedia of Applied Mechanics. For upwards of twelve years my professional life has been devoted

wholly to scientific pursuits, and for four years last past I have applied myself mainly to the study of patents and patented inventions, and incidentally have practiced as a solicitor before the Patent Office. I am accustomed to examining patented specifications and drawings to determine the unity or diversity of inventions therein set forth, and to make investigations into the state of the arts to which the same pertain. I have made a very thorough and careful study of the various processes of steel and iron making, and the machinery therefor, as set forth in the patents of the United States, England, France, and Belgium, and through a large number of printed publications. This examination was begun in February, 1881, and was continued both in this country and in Europe almost constantly throughout the period elapsing between the aforesaid month and the following month of October. It was made without reference to this controversy, of which at the time I had no knowledge. I have been repeatedly called to testify as an expert in patcauses in various circuit courts of the United States.

3 Question. Have you examined British letters patent of Frederick Siemens for the invention of improved arrangement of furnaces, which improvements are applicable to all cases where great heat is required, sealed the 27th of January, 1857, and dated 2d December, 1856, No. 2861, an exhibit of the complainants in this cause, and do you understand the specifications and drawings thereof?

46 Answer. I have examined the letters patent named in the question, and believe that I fully understand the specification and drawings thereof.

4 Question. Please state what invention is disclosed by the specification and drawings of the English letters patent 2861 of 1856, and give your reasons for any answer that you may make.

(Objected to as incompetent and irrevelant, and as new matter.)

Answer. I propose to regard this English letter patent of 1856 as showing the state of the art at its date, and in some succeeding portion of my testimony I will take occasion to point out its bearing upon the letters patent more immediately in controversy. From the investigations that I have hitherto made I am led to believe that in this English patent was described for the first time the now well-known regenerative furnace, a discovery which Mr. Coleman Sellers very properly characterizes, in his testimony heretofore given in this case, as a very remarkable invention. Broadly stated, the principle or mode of organization of the invention is this: After the products of combustion have done their work in the furnace chamber they are caused to pass over an extended surface of material capable of receiving heat from them, and thus they raise considerably the temperature of that material. Through this heated substance the air or other materials of combustion are then diverted, and become thus in turn highly heated prior to becoming consumed, or to serving their purpose in maintaining combustion. In this way a large proportion of the heat which is still contained in the flame or products of combustion in passing away from the fire-

place towards the chimney is recovered. A notable economy of fuel results. So far as I am aware, the regenerative principle, pure and stmple, and that is as involving merely heating of incoming air by outgoing products in a suitable chamber containing materials capable of receiving heat from the latter, was first definitely outlined in the old hot-air engine of Doctor Stirling, of Scotland, as far back as 1813. Various attempts were subsequently made to adapt the principle to other devices, such as to a steam engine or to a condenser, but I am not aware that it was ever applied to furnace until
47 that was done by Mr. Frederick Siemens, as described by him in the English patent now under consideration.

The drawings and specifications of English patent of 1856 show three embodiments of the invention. Without going into the details, it will suffice for the purpose of indicating the state of the art, to refer to the first of these series of drawings, inasmuch as this series, figures 1 to 6, is the most complete of the three. It will be seen that there is a central heating chamber, having on each side of it a hearth or fire-place, from which it is separated by bridges. From the hearths passages lead to two chambers which are filed with fire-brick or other refractory material, so arranged as to expose a large surface to absorb heat from the gases passing through the interstices between the bricks, and conversely to impart said heat to cold gases subsequently led through the same path. From the chambers filed with fire-brick, to which the name "regenerator" is given, two passages lead to a valve arranged in a suitable box, and located in the chimney. Means are provided for allowing the entrance of the air below this valve, and the construction of the valve is such that when it is placed in one position the cold air is diverted into one regenerator, and when placed in the opposite position the cold air is diverted into the other regenerator.

The operation of the furnace is therefore briefly as follows: The valves being suitably placed to divert the entering current of air into, for example, the regenerator marked R′, in figure 1, the air current, after passing through the regenerator proceeds over the fire in the chamber Q′ through the central heating chamber over the empty fire-place Q, and thence to the other regenerator, which it heats, and then meets the reversing valve already referred to, by which it is diverted into the chimney. Now, if the position of the valve is reversed, the incoming air enters first the generator, which has been heated by the waste gases already described; it absorbs heat from the brick-work, and finally reaches the fire-place Q, to which fuel is supplied, in a highly heated state. Of course, the consequence of this is, that in order to bring that air to whatever temperature may be suitable for use in the chamber P, a less ex-
penditure of fuel will be required than if it were necessary
48 to heat the air up from atmostpheric temperature in the fire-
place only. The foregoing, I think, sets forth the essential features of the invention described in the English patent of 1856.

(The answer is objected to upon the ground of the objection taken to the question, to wit: It is incompetent, irrelevant, and not in re-

buttal, and upon the additional ground that it is immaterial, argumentative, and volunteered.)

5 Question. Have you examined the specification and drawings of letters patent to Charles William Siemens and Frederick Siemens for the invention of improvement in furnaces, sealed the 19th of July, 1861, and dated the 22d of January, 1861, No. 167, an exhibit of the defendants in this cause; and do you understand the specifications and drawings thereof?

Answer. I have examined the letters patent named in the question, and believe I understand the drawings and specifications thereof.

6 Question. Please examine the specification and drawings of English letters patent 167 of 2861, and also the specification and drawings of English letters patent 1361 of 1856, and state how far you find what is described in specification and drawings of the latter described in the specification and drawing of the former.

(Objected to on the ground specified as to the preceding question.)

Answer. The devices as shown and described in the English patent 167, are constructed upon the same regenerative principle which I have already pointed out as set forth in the earlier English patent of 1856, that is to say: In both the furnaces of 1856 and 1861 are present regenerative chambers, which are heated by the outgoing products of combustion on their way to the chimney, and which in turn heat the incoming gases, when the direction of the current is reversed. The means of changing the direction of the current, namely, a reversing valve, is substantially the same in both, and the general structure of the regenerators of loosely arranged refractory material is similar. The construction of the furnaces, as set forth in the patent of 1861, is, however, such as to adapt them for use in connection with gas fuel, said gas being generated in a separate producer, the construction of which is here specifically detailed. This combination of the regenerative
49 furnace and the gas-producer, and the changes in the construction of the furnace attendant upon that combination constitute one of the most important of the advances in the art. In the furnaces set forth in the patent of 1856 the construction is mainly such as to adapt them to the employment of solid fuel, and in that patent no means of producing gas is described. In the patent of 1861 the combination of the gas-producer with the regenerative furnace is distinctly shown, and while, as I have before stated, the furnaces of 1861 embody the same regenerative principle as the furnaces of 1856, their construction was materially changed to adapt them to the advance already indicated and in the wide range of capabilities flowing therefrom. These changes, attending upon that improvement, constitute, generally speaking, the differences between the furnaces set forth in the patent of 1856 and those set forth in the patent of 1861.

(Answer objected to as before.)

7 Question. Have you examined Exhibit Complainants' Reissued

Letters Patent 3265, the same being a certified copy of reissued letters patent, Charles William Siemens and Frederick Siemens, for improved regenerative furnace for metallurgists and others, dated January 12, 1869, and do you understand the specification and drawings thereof?

Answer. I have examined the specification and drawing of the patent named in question, and believe that I fully understand the same.

8 Question. Please state what combination is specified in the claim of English patent 167 of 1861, which is in the following language: "Having now described the nature of our invention, and the best modes we are acquainted with of performing the same, we wish it to be understood that we do not confine ourselves to the precise details shown on the accompanying drawings, but we claim as our invention the various arrangements of regenerative furnaces worked by the gases resulting from an imperfect combustion of solid fuel in separate places, as hereinbefore set forth."

(Objected to as immaterial and incompetent; the claim speaks for itself, and the construction of it is for the court and not for the witness.)

Answer. Broadly, the combination of a means substantially as set forth for producing gases by the imperfect combustion of solid fuel with the several forms of regenerative furnaces shown and described, whereby the said furnaces may be operated by the gases produced. I understand the several forms of furnaces set forth to be the best means known to the inventors at the date of this patent for practically employing the said combination for a variety of purposes.

(Answer objected to, as the question was.)

9 Question. How far was the operation of the combination specified in the first claim of the reissue patent 3265, in the manner, and so as to be operative for the purpose as thereinbefore described, include the operation of the furnace by the gases resulting from an imperfect combustion of solid fuel in separate places, as such operation is conducted or described to be conductad in the English patent 167?

(Objected to as incompetent, the construction of the claim of the reissue 3265 being matter for the court, and not for the witness.)

Answer. The first claim of reissued letters patent No. 3265 sets forth the combination of a regenerative furnace and its chimney with a system of air and gas regenerators, the same to be constructed substantially as specified, and to be provided with conduits and dampers, whereby air and gas may be let into and through such regenerative furnace and out of the chimney, in manner and so as to be operative as and for the purposes described in the specification. On referring to the specification and drawings I find shown and described a regenerative furnace suitably arranged to be operated by gas generated in a separate producer. Broadly, to this extent the combination is the same in both the English patent of 1861 and the American reissue

3265—that is to say, in both specifications there is set forth a regenerative furnace intended to be operated by gas produced in a separate contrivance. In view, therefore, of this state of facts I am unable to regard the first claim of reissue letters patent 3265 as setting forth broadly this combination; and I am supported in this view by the limiting statements directly made in the claim itself. Reading these limiting statements in connection with the specification and drawings, I understand the apparatus set forth to be one constructed substantially as specified, and having the conduits and dampers set forth in the specification and drawings arranged as and for the purpose set forth. I do not find in the English patent 167 any regen-
51 erative furnace so constructed, nor having conduits and dampers arranged and operated as described in reissue No. 3265.

10 Question. Please state what is the invention shown and described in the American reissue letters patent No. 3265.

Answer. The specification of letters patent No. 3265 states at the outset that the object of the invention is not only to economize heat that is generally wasted, but also to produce heat by the consumption of gases and atmospheric air in mixture, the said gases being derived from suitable fuel in a furnace of a construction subsequently explained. The contrivance by which heat is economized, and in which heat is produced by the combustion of air and gas mixed, is stated to be a regenerative furnace, and the construction of such a furnace is very broadly outlined in the immediately following part of the specification; then follows a description of the gas generator in some detail, a statement of the advantages resulting from the use of gas, followed by a brief reference to the adaptation of a regenerative furnace using gas for various purposes; then succeeds the specific description of the regenerative furnace set forth in the drawings. I understand the first part of this specification—that is, down to the specific description, beginning with the words "Figures 1, 2, 3," etc., on page 3 in the specification, to indicate broadly the general class of invention to which the specific contrivance described belongs. The art of making regenerative furnaces at that time, beginning, as I have already stated, with Siemens' patent of 1856, was only eight years old. The date of the original patent on which the reissue is founded being 1864, it was requisite, therefore, for the inventor, I think, to give a general statement of the broad features and objects and purposes of the invention to enable one skilled in the art of furnace building to understand the relation to the art of the specific contrivance set forth. Now, as I have before stated that I regard the regenerative furnaces described in the English patent 167 as the best means known to the inventors in 1861 for carrying the broad combination of a regenerative furnace and a gas producer into practical effect, so also do I regard means set forth in the reissue 3265 as the best means which they knew for accomplishing the same ends in 1864, or three years later. While it may not be strictly pertinent for me to say so, I believe I only repeat the common knowledge
52 to be obtained from almost any modern text book relating to furnace construction and metallurgy that the Messrs. Siemens

have for a considerable period of years been engaged in experimenting upon furnaces of this description, and have patented, both here and abroad, a large nnmber of important improvements in metallurgical apparatus. It may be a proper assumption, therefore, that they were by no means idle during the three years intervening between their English patent of 1861 and their American patent of 1864, and that the device of 1864 may be fairly looked to as an improvement over the device of 1861.

Be this as it may, however, the fact remains that the device of 1864 as set forth specifically in reissue 3265 does, in fact, contain improvements, and very material improvements, which, in my opinion, render it capable of producing results not possible to be obtained by any device shown in the English patent 167, of 1861, and of doing so in a different way from the manner therein shown. Now, specifically as to what I find set forth in reissued letters patent No. 3265:

First. I have already stated that, on reading the first claim in connection with the specification and drawings, in my opinion the construction of the apparatus therein named is to be substantially as described; that is to say, I understand this construction to be such that the gas regenerator shall be located between the air regenerators, as shown in the drawing, more particularly in Fig. 2; that they shall be provided with conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace, and out of the chimney, also as shown and described. In referring to the specifications and drawings I find a particular construction of conduits and dampers; thus, the air conduit at the rear of the furnace is located in a space freely opened to the atmosphere, is of circular section, and is provided with a reversing valve of elliptical form. The gas conduit is of like section, and also encloses an elliptical reversing valve. Dampers or valves are provided in connection with both conduits, the damper on the air conduit serving to regulate the supply of air thereto, the damper on the gas conduit serving to regulate the supply of gas; by suitably adjusting these two dampers the air and gas is allowed to enter the furnace mixed in any desired
53 proportion. There is also a particular arrangement of conduits inside of the furnace—that is to say, the conduits from the gas regenerators, and serving to conduct the gas to the mixing chamber, are arranged between the bed of the furnace and the conduits which lead the air to the mixing chamber; the mixing chamber above these conduits is also made with a sloping roof. The effect of this arrangement is that the air is caused to enter the furnace chamber above the gas, when it sinks through the latter by its own specific gravity, and a more thorough mixing of the air and gas is the result. The foregoing is the construction and manner of arranging the devices which I understand to be recited in the first claim of reissued patent 3265.

Second. The second c aim of reissued letters patent 3265 sets forth the arrangement and combination of the air space or open chamber C with the furnace and system of regenerators arranged and applied

together substantially in manner and so as to operate as described. On referring to the specification and drawings, I find the chamber C to be located directly under the bed of the furnace and above the regenerator arches; that it is open to the atmosphere at its opposite sides or ends, and that it communicates with the chimneys, so that there is a free circulation of air through said chamber. The object of this construction is stated to be in the specification that the current of cool air may maintain the bed of the furnace as well as the arches of the regenerators at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators while they may be in operation.

Third. The third claim sets forth the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace regenerators and conduits and damper chests applied thereto, the whole being substantially as specified. On referring to the specification and drawings, I find that the chamber D is located in the rear of the upper parts of the regenerators and below the furnace, and that it is bridged over at intervals above. I also find that the chamber E is arranged below the chamber D. In the chamber D is arranged the air conduit, having its reversing valve and its air-regulating valve. In the chamber E are situated the levers communicating with both the gas and air valves, both
54 levers being in this chamber. The chamber D is freely open to the atmosphere, so that the air entering into the air conduit, when the air valve Y is suitably opened, is at normal atmospheric temperature. I understand that the claim, considered in connection with the specification and drawings, that this chamber D or that this chamber D with the space E, in which space the lever or reversing valves work, is combined with the furnace, regenerators, conduits, and damper chests, these last being constructed as specified, and in the particular manner which I have pointed out in referring to the first claim.

Fourth. The fourth claim recites: "We also claim the combination of a furnace with one or more regenerators or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom, and also with means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas during its passage into or to such furnace, for the purpose of improving or promoting combustion therein." I have read with care the views of Mr. Coleman Sellers with regard to this claim, as appear in answer to the fifth question of his direct examination, and he seems to be in difficulty over the words, "one or more," used to qualify the word "regenerators," and he appears to be of opinion that there is nothing in the specification which will enable a person skilled in the art to make a regenerative system with one regenerator, such as is described either in English patent 167 or in the present reissue. I refer to Mr. Sellers' opinion here because I considered it in making up my own. I see no trouble in making an operative regenerative furnace, substantially as is shown in the drawing attached to reissued letters patent 3265, which shall be operative with one regenerator. The process of making such furnace

consists in removing the bricks from three regenerators of the four, namely, the two gas regenerators and one air regenerator. The result of that would be one chamber; as, for example, B^4 filled with bricks, and capable of acting as a regenerator, and three chambers not containing bricks, and hence reduced to mere passages or flues. If there is any invention required in taking out the bricks of these regenerators, I fail to see where it is. There is no doubt that the efficiency of the furnace would be impaired by the proceeding. That, I think, would be a matter of degree. The furnace would still remain operative
55 for certain purposes. Of course, it would be advantageous to arrange a damper in one of the gas flues thus produced, so that all the products of combustion might be diverted through the single regeneratsr, but that damper is not essentially necessary, as the products of combustion might pass out through both the filled and empty regenerative chambers, and such portion of the products as pass through the filled chamber would, of course, tend to heat the brick work therein. I think that Mr. Sellers has labored under some misapprehension in this matter, inasmuch as he speaks of the regenerators as set forth in the English patent 167, and the reissued letters patent 3265, "as not fitted in any way to allow the incoming air or gas to pass through that regenerator and to receive heat therefrom, while at the same time the heated products of combustion are passing through the same mass of refractory material, and imparting its heat to the same." It is undoubtedly true that in no one of the regenerators shown in either of the patents is it possible for the hot air to be going in at one end and the cold air at the other (the two currents entering in opposite directions). There is nothing in either patent intimating the possibility of such a construction; and if Mr. Sellers did seriously look for anything of the sort, or even conceived the possibility of that being there, I imagine that he might, with equal readiness, take into consideration the somewhat celebrated problem of how to make two locomotives, going in opposite directions, pass each other on a single track. With this explanation, I understand the fourth claim of reissued letters patent 3265 to recite the combination of a furnace substantially as set forth, with one or more generators for receiving the waste products and receiving heat therefrom, and also with means by which the heat so intercepted may be absorbed by the influent air or gas, one generator being, in my opinion, an operative means for absorbing the heat from the outflowing gases and transferring that heat, or a portion thereof, to the influent gases.

11 Question. Please compare the specifications and drawings of Defendants' Exhibit English Patent of 1861, with the specifications and drawings of Complainants' Exhibit Reissued Letters Patent No. 3265, and state to what extent you find what is described and
56 shown in said reissue No. 3265, described and shown, or comprised in said English patent of 1861.

Answer. The two most important improvements which I have thus far found set forth in reissue 3265 are, first, the arrangement of the regenerators, and their flues or conduits, whereby the gas is caused to enter the mixing chamber prior to entering the heating

chamber of the furnace, above the air current; and second, the arrangement in connection with the air and gas conduits of the valves, by means of which the proportions of air and gas in the mixture may be regulated. These two improvements are clearly and distinctly shown in the American reissue. They are not shown in any construction of furnace represented in English patent 167. The specification of 3265 specifically sets forth and the drawings show what is stated to be a puddling furnace. Figures 11, 12, and 13 of English patent 167, and their accompanying description, are also stated to set forth a furnace adapted for the purpose of puddling iron. I propose now to compare these two furnaces with reference to the first important improvement above cited. Reference to the drawings, figures 11, 12, and 13, of the English patent, shows that the gas regenerators are shown by the letters C^1 and C^3 and that the air regenerators are indicated by the letters C^2 and C^4. It will be obvious best from figure 12 that the two gas regenerators are here not arranged between the two air regenerators, but are placed beside them. It also appears that the gas entering the regenerator C by the flue G rises up through that regenerator, passes over the furnace bed, then down through the regenerator C^1, and finally proceeds by the passage F to the reversing valve and chimney. It also appears that the air proceeds by the passage I to the regenerator C^4, then over the furnace bed down through the regenerator C^2, and then passes by the passage H to the valve or chimney. It appears, therefore, that the gas, after passing through the first regenerator rises up through an independent flue marked J, and that the air from the regenerator C^4 rises up through an independent flue marked K. The upper end of these flues marked J and K are at the same level, the exit orifices face each other, so that the outflowing gas current, meets the outflowing air current and the two pass through the orifices J^1 and K^1, and then over the bridge *b* and into the furnace chamber, wherein is the metal to be treated.

57 Owing to the witness being obliged to depart for a train the examination was adjourned to Tuesday, November 28, 1882, at 10 a. m.

(Examination resumed Tuesday, November 28th, 1882, at 10 a. m.)

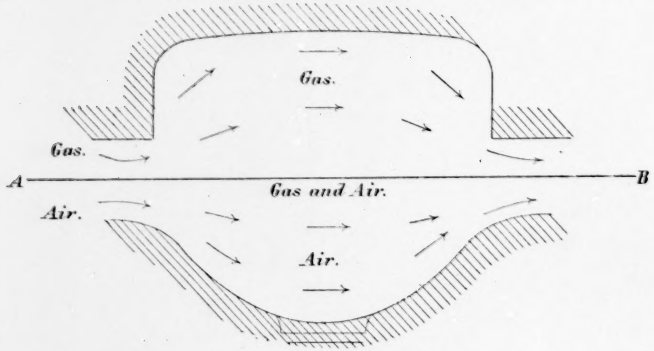
Parties present as before.

Answer to Question 11 continued:

As these two currents are both under pressure there appears to be less tendency for one to mingle with the other than for both to find their escape where there is the least resistance offered to their doing so. They will thus enter the furnace chamber side by side, and in expanding in said chamber the air current will tend to sweep around one side and the gas current around the other. It will be noticed that the increase in the size of the chamber allows of a wide separation of these two currents, so that whatever mixing of air and gas may take place therein can occur only at about the middle of the chamber, and that as the sides are approached the mixture will be less and less perfect until at the sides it may be possible to find un-

mixed air and unmixed gas. This is exemplified by rough sketch here produced and marked "Complainants' Sketch No. 1," which shows a plan of the furnace chamber. At one side of the line A B

Complainants' Sketch No. 1,



58 the mixed gas and air will contain increasing proportions of gas as the side of the furnace is neared, while on the other side of the line A B there will be progressively a greater portion of air in the mixture. A mixture of equal parts of gas and air will occur obviously at or about the line A B.

For a partial explanation of what would happen in a furnace under these conditions, I refer to Mr. Sellers' answer to cross-question 41. There he says: "If the amount of air admitted to the furnace be greater than is needed to unite with and consume the gas and the fuel furnishing the gas, there will remain oxygen in the furnace which can unite with the heated metal, and so cause it to be burnt or consumed to the extent of the unappropriated oxygen and the excess of air so admitted." I agree with Mr. Sellers in this opinion, which sets forth, I think, just what would happen in that part of the furnace chamber wherein, as I have already pointed out, there is an excess of air.

In addition to this burning of the metal there would, I think, be a tendency to burn out the inside of the furnace, or at all events it might be expected that this part of the furnace would become deteriorated before other parts.

Now, on the other side of the line A B, where the proportion of gas is more or less in excess, there would, I think, be an extra carbonization of the metal, the production of smoke in the furnace due to the unconsumed carbon, and this, besides preventing the workmen from seeing the interior of the chamber, would cause a deposition of soot in the regenerative passages, and the consequent choking up of the same. I think it will be evident that there can be no uniformity in the mixture of air and gas in the furnace, and no uniformity in the action of such air and gas as is admitted upon the metal, so long as the construction of the furnace is as represented in figure 11 of English patent No. 167.

On referring now to the furnace shown in United States reissue 3265, it will be seen best from figure 2 of the drawing that the air current is led from the air generator so as to enter the furnace chamber above the gas current. There will therefore be in the chamber at the outset two layers or strata, so to speak—a stratum of air above and a stratum of gas below. The difference between this
59 arrangement and the English patent 176 is exemplified in the diagram which I now produce, marked

Complainants' Sketch No. 2.

Fig. 1. Reissue 3265.

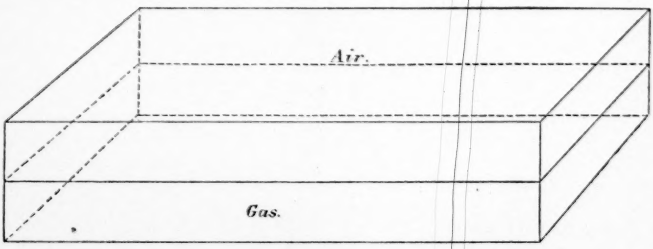


Fig. 2. Eng. Pat. 167.

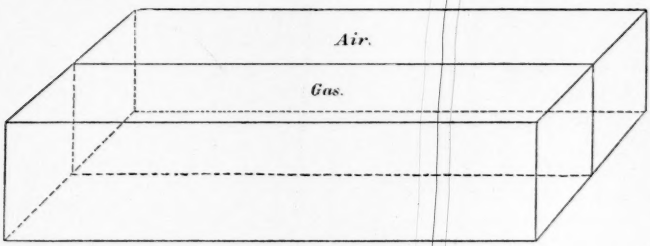


Figure 1 illustrates the stratum of air above the stratum of gas, as in reissue 3265. Figure 2 shows the current of air beside the current of gas, as in English patent 167.

The result of the arrangement of the currents, as adopted in reissue 3265, is the calling into play of a natural force which is not utilized for the purpose through the arrangement of currents shown in English patent 167, and that is the tendency of the air by its own specific gravity to settle down through the gas, and so mix with the latter, and this intermingling takes place over the whole width of the furnace bed; the conditions being substantially the same everywhere. Or, to express this difference in more general terms, in the English patent 167, figure 11, two currents, both under pressure, coming from opposite directions, meet each other. The ten-
60 dency is recoil and separation. In United States reissue 3265 there are two parallel currents, one over the other, and there

is a direct tendency for the upper one, by its own gravity, to mingle with the lower one.

I propose now to consider the matter of the air and gas valves to regulate the proportions of air and gas admitted to the furnace. The presence of these valves being an important improvement, as set forth in the reissue 3265, and not in the English patent 167. The utility of such valves in general is fully set forth in Mr. Seliers' answer to cross-question 41. On referring to his answer to cross-question 29, I understand that he considers that valves of this description are in fact set forth in English patent 167. Mr. Sellers, in his answer to cross-question 30, says that those valves are not figured and shown in English patent 167, but "merely described as necessary." He quotes two extracts from the provisional specification and the specification proper, respectively, as follows: "Dampers are provided in the cold air and gas channels by which the quantity and quality of the flame can be regulated with the utmost nicety," and "causing a plenum of pressure within the same which is capable of being modified or regulated by valves for the admission of gas and air to the regenerators." I do not understand that Mr. Sellers designates any other parts of the specification as containing similar or further statements of the same kind, when he speaks of these quoted extracts merely as "allusion to regulating valves." I do not see how any person skilled in the art could build a furnace with regulating valves by the aid of a mere allusion to the latter, so that it appears that in order to gain any definite knowledge on the subject, principal recourse must be had to the drawings of English patent 167.

On these drawings I can find no regulating valves, such as shown at X and Y in reissue 3265, nor any equivalents for them, more particularly in the drawings 1, 2, 3, 4 of sheet 1, and 11, 12, 13 of sheet 2. If the quotations made by Mr. Sellers are taken as meaning that the inventor knew of devices for that purpose, he certainly failed to impart that knowledge in any practical manner in his specification and drawing. There is a possible assumption that the inventor might have had some idea of using his reversing valve for this purpose, which is supported by the fact that he speaks of
61 "reversing valves or dampers," using the terms, apparently, synonymously in several places in his specification, but I fail to see how the reversing valves can be properly used for this purpose without great waste and possible danger.

I notice that, in answer to question 43, Mr. Sellers bases an inference that some other opening for the admission of air is intended to be supplied in the apparatus shown in figure 3 of sheet 1 of the drawings, because the orifices present and shown for supplying air are, in his opinion, inadequate for the purpose. I do not see the logic of this argument. By a similar reasoning every original device produced in the past might be regarded as containing and including every improvement ever made upon it. The fact is, that no such additional opening is shown, and Mr. Sellers is silent as to how he supposes it to have been arranged.

Another improvement contained in reissue 3265, and not in the

patent 167, which I regard as resulting in a material difference, lies in the means of obtaining the air supply and the devices thereto pertaining.

In figures 1, 2, 3, and 4, sheet 1, of English patent 167, the passages shown, whereby the air enters the furnace, extend under the bed and communicate with the atmosphere, on the one side through the conduit F, and on the other side with the conduit I of the regenerator. This arrangement, Mr. Sellers substantially says, in answer to question 43, is inoperative, and I agree with him.

Comparing more specifically the arrangement shown in the aforesaid engines in English patent 167 and that in the reissue 3265, it will be seen that in 3265 the air is taken by the valve Y, located in the chamber D, which chamber is open freely to the atmosphere. This arrangement is not inoperative, and is, in my opinion, materially different from that depicted in the English patent.

In his answer to question 6, Mr. Sellers makes reference to figure 11 of English patent 167. If he means to state that the chamber in the vicinity of the letter D in the figure 11 is an equivalent for the chamber D in the reissue 3265, I think he is under some misapprehension in his interpretation of the drawings.

Figure 11 is a vertical section on the broken line A, B, C, D,
62 of figure 13, so that the section is taken through the gas chamber and not through the air chamber, the valve D being the gas-reversing valve. I do not suppose, of course, that Mr. Sellers meant to say that a closed gas chamber is in anywise the equivalent of an open air chamber, but my inference is that he understands the chamber in which is located the air-reversing valve E to be arranged about the same as the chamber in which is the gas-reversing valve D. This, however, is an assumption, because in this respect the drawings, figures 11, 12, and 13, are quite blind. All that is definitely shown about the air conduits is their general plan, and there is no drawing showing positively whether they are roofed over or not. I assume that the former is the case, which leads to the further question as to how the air is brought into them. The drawings on their face show no means supposing the air conduits to be roofed over.

From my investigations into English patents in general, however, I have found it to be the common practice to represent, usually, one apparatus of the arrangement patented in specific form, with details, and then to show various modifications without details, which are common to all, or with only so much as is necessary for the reader to connect one form with the other. Applying this to drawings of English patent 167, I infer, as no means are shown of leading the air to closed conduits in figure 11, that that means is intended to be substantially the same as shown in the more detailed drawings, figure 1. This would involve passages leading from the air duct *a* to the air-reversing valve E, the air being then drawn, as in figure 1, under the bed of the furnace and into the air conduit. This would result in substantially the same differences as existing between devices shown in figure 11 of English patent 167 and reissue 3265 as those already pointed out as existing between ar-

rangement shown in figure 1 of English patent 167 and the reissue 3265.

The foregoing include, in my opinion, the principal and substantial differences between what is shown in English patent 167 and the reissue 3265.

Cross-examined by Mr. BALDWIN:

(Reserving the objection taken by defendants' counsel to witness, he cross-examines as follows:)

63 X 12 Question. At what age did you graduate at the Naval Academy?

Answer. At eighteen.

X 13 Question. Have you at any time had any practical experience in any branch in applied mechanics, and, if yea, what?

Answer. If the term practical experience means whether I have been a working mechanic, I answer no; if it means whether I have taken part in the designing and testing of machinery, and the study and examination of the same practically, I answer yes. While in the navy I was required to study steam engineering, to render myself capable of practically managing boilers and engines. I personally performed the duty of all classes of attendance thereon from fireman to engineer. Constantly, during my period of connection with the Scientific American, I was called upon to examine machinery of almost every description and to understand it with sufficient thoroughness and accuracy to be able to discuss and criticize it in the columns of that journal. In the majority of cases this machinery was entirely new, and my study had to be original work, and I could get no help from books. This same work was continued while editing Appleton's Encyclopedia of Applied Mechanics, and in the Messrs. Sellers' own establishment, where, at their request and under my direction, was conducted an elaborate trial of steam injectors, which they afterwards published as authoritative and gave out to the world through the medium of their advertisements, as I am informed and believe. Various other tests for that work, the Encyclopedia, were also arranged by me, and also it was necessary for me to examine many machines at different times, in order to describe them in that book, which I did. Subsequently I have been in the employ of the Holly Manufacturing Company as engineer, and have taken part in the designing and laying out of waterworks. I have also taken part in the designing of machinery for various purposes, which I cannot now detail. I also consider the constant preparation of applications for patents as experience in applied mechanics of the most practical character.

(Adjourned to 2 o'clock p. m.)

64 (Examination resumed at 2 o'clock p. m.)

X 14 Question. In your last answer you refer to some tests on injectors as in Appleton's Encyclopedia of Applied Mechanics. In volume 2, on page 162, and following, I find: "The Sellers Injectors; report of tests conducted by Park Benjamin, Scientific Expert

Office, May, 1879, at the works of Messrs. W. Sellers & Co., Philadelphia. Trials in charge of Richard H. Buel, C. E." Is that the article which you referred to in your last answer?

Answer. That article describes the tests referred to conducted under my direction at the Messrs. Sellers' establishment.

X 15 Question. Were you ever at their establishment while those tests were being conducted?

Answer. No, sir. The scheme for the tests was prepared by Mr. Buel and myself, and was sent down for Messrs. Sellers' approval, modified, if I remember rightly, in some respects in accordance with their desires, and then, after all its details had been agreed upon, I engaged Mr. Buel to go down there to Messrs. Sellers' establishment and carry out the scheme. Mr. Buel reported to me. I revised the report, and adopted it, and became responsible for it, and published it where counsel has found it. My duties at that time made my work so confining as to render it simply impossible to personally attend to practical details of tests.

X 16 Question. Did you ever design, or construct, or operate, or direct the designing, construction, or operation of a regenerative furnace; and, if yea, what kind was it, and when and where?

Answer. No, sir.

X 17 Question. If you have no objection, will you state the connection in which you made the examination of steel and iron making processes, and the machinery therefor, referred to in your answer to question 2?

Answer. I was employed by a certain corporation organized for steel manufacture to thoroughly examine all I could find published, both in this country and in Europe, relating to certain patents which involved, among other things, the Siemens regenerative system.

X 18 Question. Did you, in the course of that examination,
65 trace the history of the Siemens system as you have given it in your examination-in-chief?

Answer. I found, during that examination, the early attempts to make regenerators, and also then determined that the Siemens patent of 1856 was, so far as I could discover, the first in which the regenerative system is shown as applied to a furnace. Then I followed down the state of the art, examining all the patents relating to it, of course examining more particularly those bearing upon the apparatus the novelty of which the investigation was intended to determine. I recollect reading over carefully, and understanding and having a general idea of, the relative bearing at the time of all the patents I have testified about in my direct examination; but then there was no reason for going into the comparison of them particularly as I have now done.

X 19 Question. Down to what date did you bring that investigation, and how far back did you carry it?

Answer. That is hard to say. I think the latest patent submitted to me was dated somewhere in 1879, and I went back, of course, as far as I could, in all available publications of patents or otherwise.

X 20 Question. In that investigation was your attention arrested

by or directed to the discriminations you have made in your examination-in-chief between the patents of Frederick Siemens in 1856 and of F. and C. W. Siemens in 1861, in England, and the reissue 3265 in America.

Answer. If this question is asked for the purpose of making anything in the way of an argument that I might, during that investigation, have noticed differences which I have pointed out in the present case, and have been struck by them, or something of that sort, I should have to protest against this line of questions, and claim professional privilege in not categorically answering questions of the kind, for the reason that I can't do so intelligibly without spreading on the record the exact data that I had to determine and to search for, and why I was obliged, from the very magnitude of the search, to keep as close thereto as practicable. I cannot do this without publishing matters which I do not think I ought to divulge. Generally, however, I would say that there was no occasion for me to make any such detailed comparison of these patents as I have done in this case, and that the Siemens regenerative system
66 was not one of the specific subjects the novelty of which was to be determined if possible

X 21 Question. When were you retained in this case?

Answer. I think the first knowledge of this case was given to me by Mr. Whitman some time last summer, and I think I was definitely requested by Messrs. Siemens' representatives to appear as a witness some time in June.

X 22 Question. Prior to that time had you been engaged in any way on behalf of the Messrs. Siemens, or of their representatives, in connection with this patent 3265 or its original, No. 41788, in America?

Answer. No, sir. I might add that the interests that I represented in the investigations I referred to were adverse to Messrs. Siemens.

X 23 Question. Did not the deposition of Mr. Coleman Sellers in this case first show you the differences which you have pointed out, whether in his answers or in questions propounded to him, whether on direct or on cross-examination, between the English patent 167 and the American reissue 3265?

Answer. I think not. If my memory serves me correctly, I had the American and English patents before me, and I had made up my mind about them on many points before I ever saw Mr. Sellers' deposition. Then a copy of it was sent to me and I went over the matter in the light of what I read then.

X 24 Question. As a solicitor of patents of such experience as you have mentioned in drawing specifications, do you generally rely upon the drawing, without any reference thereto in the specification, to define the particular improvement which is the subject of the claim?

Answer. Drawing a specification of a patent is one thing and the understanding of it after it has been drawn by another is another thing. Personally I like to make my specifications as full and complete as possible, and endeavor to do so. When I am asked to state what is set forth in a patent I take both drawing and specification

to be equally parts thereof, both to be given due weight in reaching a conclusion.

X 25 Question. To which would you give most weight in ascertaining the meaning of a patent, the descriptive parts of the
67 specification setting out the general purpose of construction and operation of the improvement, or unlettered parts of the drawings annexed to exemplify the application of the general principles specified in the specification?

Answer. That would depend a good deal on circumstances existing in each patent. If the drawing distinctly and clearly sets forth certain things operating in a certain way, I should look upon those things as included in the invention, provided they were operative and the invention could fairly include them under the state of the art.

X 26 Question. In Appleton's Cyclopedia of Applied Mechanics, vol. II., page 173, and the following, the article on iron-making processes is signed W. K., at page 204; who was that?

Answer. On page immediately following the preface it is stated that the initials of the writers are appended to the articles written by them either wholly or in part, and that Mr. William Kent, C. E., wrote the article relating to iron making. He is the W. K.

X 27 Question. On pages 187 and 188 is a drawing and description of a Siemens regenerative furnace for heating iron, the text stating "that the gases from the producer, entering at R R on the right, and the air for their combustion entering at O O, pass upward through the heated regenerators L L, and through the flues M M to the working chambers K K, where they meet and ignite." Please state whether you find anything said there about how they meet, and whether they enter side by side or one over the other.

(Objected to as not cross-examination.)

Answer. This drawing shows distinctly the air coming in over the gas, indicating it by arrows. There is no specific statement in words to this effect, nor do I see how there could be, in view of the fact that the writer has compressed his detailed description of the furnace represented in the drawing into seven lines of print.

X 28 Question. You say that from the investigations which you have made, you are led to believe that in the Frederick Siemens patent of 1856, No. 2861, was described for the first time the now well-known regenerative furnace, and you have previously said that you have examined the American, French, English, and Belgian patent of processes for making iron and steel, and you say so
68 far as you are aware the regenerative principle, pure and simple, and that is as involving the heating of incoming air by outgoing products of combustion in a suitable chamber, containing materials capable of receiving heat from the latter, was first definitely outlined in the Sterling hot-air engine, but you are not aware that it was ever applied to a furnace until that was done by Mr. Frederick Siemens, as described by him in English patent 2861, of 1856. Can you recall no earlier instance on further reflection?

Answer. There has been a somewhat doubtful story floating about

for some years about an alleged discovery of an alleged furnace, said to be built on something like the regenerative principle in an ancient abbey or monastery or castle in Germany.

(Counsel for defendants, to save time, begs to call the attention of the witness that the question relates, or was intended to relate, not to floating stories, but to patents, and desires it to be considered as amended to that effect, if he misunderstood it; and further, to patents between 1813, Sterling's date, and 1856, Frederick Siemens' date.)

I should not have referred to the story in question had not Mr. Jeans, in his new and exhaustive work on steel, given a paragraph to it, and I supposed counsel had some reference to that. I found no patents for regenerative furnace prior to Frederick Siemens' patent of 1856.

X 29 Question. Did you find no patent in which the regenerative principle, involving the heating of incoming air by outgoing products, in a suitable chamber capable of receiving heat from the latter, was definitely outlined as applied to a furnace before 1856?

Answer. None that I can now remember. I formed the impression then, and have had it since, that Siemens' patent of 1856 describes the invention of the regenerative furnace.

X 30 Question. Did you never see the American patent, issued in 1842 and reissued in 1845 to Detmold, assignee of Faber du Faur?

Answer. Possibly. I cannot say definitely.

X 31 Question. Do you remember anything about them, if you saw them.

Answer. I do not now. The inventors' names, as stated, sound familiar.

69 X 32 Question. Do you remember any patent granted to Detmold prior to 1856?

Answer. All this seems to be presupposing that I have been making an elaborate search to determine the novelty of the Siemens regenerative system, and I have said I did not do it with that specific object. I have given my best impressions of the Siemens patent, 1856, which I have held ever since, and I certainly don't and can't remember the name of every inventor of American patent that I happen to have examined, without the help of the written digest of the investigation, which I have not here. I say the name of Detmold sounds familiar to me, as I have probably examined some patent or publication under that name, which, for some reason, fixed itself in my memory, but I do not recollect that that patent or publication had any particular bearing on that investigation.

X 33 Question. You have assumed to have made an exhaustive investigation, and to have concluded therefrom that the Siemens patent of 1856 was the first application of the regenerative principle to a furnace; please look at the certified copy now shown you of United States patent, granted to Christian Edward Detmold, assignee of Wilhelm von Faber du Faur, of April 16, 1842, antedated April 12, 1841, No. 2558, for improvement in heating furnaces, etc., and the reissued letters-patent granted said Detmold, assignee of said du Faur, granted January 23, 1845, and state if you do not find in

those patents respectively the application of the regenerative principle to a furnace?

Answer. I desire to state, on looking over the two patents handed me by counsel, that I have not seen them before, to my knowledge, and, therefore, assume that the familiarity of the name is a coincidence due to some other reason. As I have not read them, and do not know their contents. I state that I shall devote as much time to examining them as may be necessary for me to understand them fully and thoroughly. (Witness proceeds to examine patent.) On the margin of the reissued letters patent which has been handed to me I find various annotations and pencil marks, which have called my attention to the adjoining passage, which describes an arrangement which might be mistaken for a regenerative apparatus; and, unless I am directed otherwise by defendants' counsel, I shall assume, in order to save further time, that this is the feature he more particularly desires me to consider in the patent.

(Defendants' counsel requests the witness to answer with reference to the patent itself, without being restricted to pencil marks or to any part of the patent less than the whole, if it be necessary to examine the whole patent in order to answer.)

I shall discuss that portion first, and rely upon the counsel asking such questions as he may desire for further information. The arrangement described is as follows: A system of pipes, P, is placed in a chamber, L, which communicates with the stack, E, by openings marked *l;* the pipe, P, extends outward, finally bends down and carries at its lower end a small pipe or tuyere projecting into the furnace chamber. I understand from the specification that the gases from the furnace hearth enter the chamber, *l*, surround the system of the pipe, P, and heat the air which circulates through said pipe, P, so that said air is finally injected into the furnace as a hot blast. This furnace is constructed somewhat on the principle of the old house-warming furnace, which I believe has been known for a very long time. The essential features of such a furnace are, ordinarily, a combustion chamber, receiving a direct supply of air beneath its grate, and provided with a chimney. Over the combustion chamber there is generally arranged a compartment, very commonly consisting of tubular projections, whereby a greater expanse of metal is obtained for the purpose of heating the air therein. This air is taken through an opening communicating with the atmosphere, passes into its heating chamber, which is warmed by the products of combustion, or waste gases, if you choose to call it so, and thence goes to the various registers around the building to be warmed. Reference to the drawing, figure 1, Detmold's Blast Furnace, shows the hearth and the chimney, and the space over the hearth; these parts corresponding to those already pointed out in a warming furnace. There is also shown an independent passage for the air, which passage leads through a space heated by the products of combustion; the air in said passage being warmed by conduction through the walls thereof, as the air is warmed in the heating chamber of a house-warming furnace; but the end of the hot

air flue, instead of being taken to a room, for example, to be warmed, is so led as to deliver its air current into the furnace. I don't think this has any more to do with Siemens' regenerative
71 system, as figured in his patent of 1856, than has the ordinary warming furnace which I have described. I am not aware that I have intimated that Mr. Siemens was the first man to utilize the outgoing gases from a furnace, inasmuch, and I believe, that such gases have been used for heating feed water, for example, for steam boilers; and I believe such utilization is very old. I should explain further that where a solid hearth is used, as in Detmold's furnace, all the air supplied must, of course, come in by the air pipe, and in this respect it necessarily differs from a warming furnace, in which the air comes in from beneath the grate, to which I have endeavored to indicate its analogy. I stop my examination of the patent at this point, and if the counsel desires me to go any further into the patent I will do so.

X 34 Question. You have answered so far with reference to the reissued patent of January, 1845, have you not?

Answer. Yes, sir.

X 35 Question. Do you not find in that patent the application of the regenerative principle to a furnace?

Answer. I don't find the apparatus shown in said reissued letters patent, and hereto described by me, to have the same principle or mode of organization as I have already stated to exist in Siemens' patent of 1856. The term "regenerator," Mr. Siemens says, applies to chambers containing large aggregate surfaces for absorbing heat, and I have already stated that the regenerative principle, pure and simple—that is, as merely involving the heating of the incoming air in a chamber containing materials capable of receiving heat from the latter — was first outlined in the old Sterling engine. A regenerator, I have understood, must contain materials capable of receiving heat, and then giving it off by radiation. This accords with Mr. Siemens' use of the term, and with the construction of the regenerators in the old Sterling engine. Such is the regenerator which Sterling described, and such is the regenerator used by Siemens, and such is not the regenerator used by Detmold.

X 36 Question. Do you not find in the patent last referred to the application of the regenerative principle to a puddling furnace for puddling iron?

Answer. In the light of my preceding explanation, no. What I do find is a puddling furnace provided with means for heating the blast by the outgoing products of combustion.

72 X 37 Question. Don't you find means for heating the air?

Answer. The blast is, of course, heated; but this is not regeneration in the sense which I have already explained.

X 38 Question. Don't you find, fully described, a gas producer for generating carbonic oxide at a distance from the furnace to which it is to be applied in the puddling operation, and of introducing it into that furnace with air, and means for thoroughly commingling the air and the gas thus introduced?

Answer. There are some more pencil marks on the margin which

call my attention to the passage wherein it is stated that combustible gasses are collected from a cupola and other furnaces or fire-places, or from furnaces constructed for the express purpose of producing them, and to conduct them to the other furnaces or structures which are to be heated by them, whereby their combustion is affected by mixing with them an adequate quantity of heated air. And I find set forth in the drawings means for drawing off the gas from the producing chamber, and for conducting the same to a furnace chamber where the said gas is mixed with air.

X 39 Question. As these pencil marks seemed to embarrass you, and may in some way restrict your answers, let us see if we can't relieve you; for example, do you find in said reissued patent to Detmold, of January 23d, 1845, these words: "To all persons whom it may concern: Be it known that the following is a full and exact description of a new and useful invention for generating and applying heat"?

Answer. Yes.

X 40 Question. Do you find therein these words: "In all blast and other furnaces employed in the manufacture of iron and other metals a large quantity of gases, principally consisting of the carbonic oxide gas, is generated and escapes unconsumed out of the furnace"?

Answer. Yes.

X 41. Question. Do you find these words therein: "I have discovered and invented a new mode of employing other, otherwise lost, gases usefully, and of producing by their combustion a most intense temperature, which may be applied with great advantage in the manufacture of iron and other metals, to the heating of steam boilers, and generally wherever a high temperature is required"?

Answer. Yes.

73 X 42 Question. Do you find therein these words: "I collect these combustible gases from glass cupola and other furnaces or fire-places, or from furnaces constructed for the express purpose of producing them, and conduct them to the other furnaces or structures that are to be heated by them, where their combustion is effected by mixing with them an adequate quantity of heated air in numerous small streams under a pressure greater than that of the atmosphere. This may be done by forcing the heated air through apertures in sides of pipes or other apparatus, but is best effected by forcing it amidst the combustible gases through a system of blow pipes; thus the oxygen of the atmosphere air becomes thoroughly incorporated with the combustive gases, so that their combustion is at once completely effected, and a heat produced sufficiently high for any kind of manufacture"?

Answer. Yes, sir.

X 43 Question. Do you find therein these words: "My invention, therefore, consists: 1. In a new mode of obtaining and collecting carbonic oxide and other combustible gases from blast and other furnaces or fire-places, or from furnaces constructed for the express purpose of producing the same. 2. In a new mode of effecting the

perfect combustion of the gases so obtained. Having thus generally stated the character of my invention, I will describe more particularly its application to the manufacture of iron"?

Answer. Yes.

(To save time the complainants' counsel agree that the certified copies shown to the witness, and one of which is referred to in the foregoing question, may be put in evidence by the defendants, printed in the defendants' record, and used at the hearing of this cause, as showing the state of the art; said copies are accordingly put in evidence, and are marked, respectively, Defendants Exhibit Detmold Patent, as assignee of Faber du Faur, No. 2558, of April 16, 1842, C. F. Z., N. P., Nov. 28, 1882, and Detmold patent, as assignee of Faber du Faur, reissue No. 67, of Jan. 23, 1845, C. F. Z., N. P., Nov. 28, 1882, and the defendants' counsel asks the witness:)

X 44 Question. In view of these two Detmold patents, do you desire to qualify your answer to question 4 direct, as to the state of the art at the date of the Siemens patent of 1856?

Answer. If I had known of these patents prior to testifying,
74 which I did not (nor do I believe that I could have encountered them in the investigation hitherto referred to, as they seem to involve none of the essential objects of that search), I think I should have made my statement of the regenerative principle, as exemplified in Sterling's old engine, more definite by more particularly referring to the materials adapted both to absorb heat from, and radiate heat to, the passing air, which materials were, in fact, thus arranged in Sterling's apparatus. I concede that the construction which defendants' counsel has placed upon my statement, according to his understanding of it, is broadly shown in Detmold's patents, which he has introduced.

X 45 Question. In view of the Detmold Faber du Faur patents, do you wish to qualify your statement in answer to question 6, that this combination of the regenerative furnace and the gas producer, and the changes in the construction of the furnace attendant upon that combination, constitute one of the most important advances in the art, as you have applied that statement in that answer to the Siemens patent of 1861 as an advance upon the Siemens patent of 1856?

Answer. No, sir; not in view of the statements of that answer.

X 46 Question. Then you would restrict the statement in the answer to question 6 to the advance of the Siemens patent of 1861 upon the Siemens patent of 1656, and not include in that answer generally the combination of a gas producer with a regenerative system, such as shown in the Detmold Faber du Faur patents?

Answer. Yes; it being understood that I do not admit, and have not intended to admit, that the Detmold system of heating the blast is a regenerative system in the sense that Sterling's or Siemens' is.

X 47 Question. Given the Faber du Faur system whatever, you please to call it, including the producer for generating the gas in a separate place, and the Siemens patent of 1856 as representing the Siemens regenerative system at that date, would you consider the

Siemens patent of 1861 a very great advance in the art, so far as it consisted, merely in the combination of the regenerative system and a gas producer?

Answer. No; for the reason that the English patent of 1856 recognizes such a combination, inasmuch as it shows in figures 1,
75 2, and 3, of sheet 2, an arrangement of furnace in which it is stated that carburetted hydrogen or other inflammable gas may be used. The gas, I understand, was to be made in a separate producer, which is not shown in the drawing.

X 48 Question. Then would you not reduce your view of the advance in the art of the Siemens English patent 167 of 1861 to the changes in the details of construction with the changes incident thereto in the operation of a furnace worked by the regenerative system of 1856?

Answer. That is the idea I intended to convey in the beginning. I said this combination of the regenerative furnace and the gas producer and the changes in the construction attendant upon that combination constitute an important advance; I meant the whole statement to be taken together and not in separated form.

X 49 Question. To prevent misapprehension, let me understand, if we are to take it, that now you mean that the advance in the art in the Siemens patent of 1861 was not the combination for the first time of *a* regenerative furnace and *a* gas producer, but a combination of *the* regenerative furnace and *the* gas producer as described and shown in the Siemens patent 167 of 1861?

Answer. The form of the question seems to presuppose a change of view on my part which I am not aware of having made. The Siemens patent of 1856 does show a regenerative furnace adapted to be used with a gas producer. No gas producer is, however, shown. It would, of course, involve no invention to take the gas producer from the Detmold apparatus, or any other producer known at the date of the Siemens patent of 1856, and attach it to the regenerative furnace there shown. The particular form or furnace there figured seems to have been one adapted for heating a muffle and not arranged for a puddling furnace. On the other hand, in the arrangement shown in figures 1, 2, and 3, which is provided with a hearth, and is adapted for metallurgical purposes, there is no means shown of applying gas, but, on the contrary, fire-places in the furnaces are used. Now, in the patent of 1861 the advance is obviously not the mere combination of any Siemens regenerator with any means of producing gas, but I have regarded it as an advance in so much as it shows, or attempts to show, the combination of a gas producer, specially contrived for the purpose, with a number of differ-
76 ent forms of furnaces adapted to a variety of purposes. This was my meaning when I said, speaking of the furnaces of 1861, that "their construction was materially changed to adapt them to the advance already indicated and the wide range of capability flowing therefrom."

X 50 Question. Then are we to take it that you recognize in the Defendants' Exhibit Detmold Patent a combination with a regenerative system, however crude, with a gas producer for supplying

perfect combustion of the gases so obtained. Having thus generally stated the character of my invention, I will describe more particularly its application to the manufacture of iron"?

Answer. Yes.

(To save time the complainants' counsel agree that the certified copies shown to the witness, and one of which is referred to in the foregoing question, may be put in evidence by the defendants, printed in the defendants' record, and used at the hearing of this cause, as showing the state of the art; said copies are accordingly put in evidence, and are marked, respectively, Defendants Exhibit Detmold Patent, as assignee of Faber du Faur, No. 2558, of April 16, 1842, C. F. Z., N. P., Nov. 28, 1882, and Detmold patent, as assignee of Faber du Faur, reissue No. 67, of Jan. 23, 1845, C. F. Z., N. P., Nov. 28, 1882, and the defendants' counsel asks the witness:)

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X 45 Question. In view of the Detmold Faber du Faur patents, do you wish to qualify your statement in answer to question 6, that this combination of the regenerative furnace and the gas producer, and the changes in the construction of the furnace attendant upon that combination, constitute one of the most important advances in the art, as you have applied that statement in that answer to the Siemens patent of 1861 as an advance upon the Siemens patent of 1856?

Answer. No, sir; not in view of the statements of that answer.

X 46 Question. Then you would restrict the statement in the answer to question 6 to the advance of the Siemens patent of 1861 upon the Siemens patent of 1656, and not include in that answer generally the combination of a gas producer with a regenerative system, such as shown in the Detmold Faber du Faur patents?

Answer. Yes; it being understood that I do not admit, and have not intended to admit, that the Detmold system of heating the blast is a regenerative system in the sense that Sterling's or Siemens' is.

X 47 Question. Given the Faber du Faur system whatever, you please to call it, including the producer for generating the gas in a separate place, and the Siemens patent of 1856 as representing the Siemens regenerative system at that date, would you consider the

Siemens patent of 1861 a very great advance in the art, so far as it consisted, merely in the combination of the regenerative system and a gas producer?

Answer. No; for the reason that the English patent of 1856 recognizes such a combination, inasmuch as it shows in figures 1,
75 2, and 3, of sheet 2, an arrangement of furnace in which it is stated that carburetted hydrogen or other inflammable gas may be used. The gas, I understand, was to be made in a separate producer, which is not shown in the drawing.

X 48 Question. Then would you not reduce your view of the advance in the art of the Siemens English patent 167 of 1861 to the changes in the details of construction with the changes incident thereto in the operation of a furnace worked by the regenerative system of 1856?

Answer. That is the idea I intended to convey in the beginning. I said this combination of the regenerative furnace and the gas producer and the changes in the construction attendant upon that combination constitute an important advance; I meant the whole statement to be taken together and not in separated form.

X 49 Question. To prevent misapprehension, let me understand, if we are to take it, that now you mean that the advance in the art in the Siemens patent of 1861 was not the combination for the first time of *a* regenerative furnace and *a* gas producer, but a combination of *the* regenerative furnace and *the* gas producer as described and shown in the Siemens patent 167 of 1861?

Answer. The form of the question seems to presuppose a change of view on my part which I am not aware of having made. The Siemens patent of 1856 does show a regenerative furnace adapted to be used with a gas producer. No gas producer is, however, shown. It would, of course, involve no invention to take the gas producer from the Detmold apparatus, or any other producer known at the date of the Siemens patent of 1856, and attach it to the regenerative furnace there shown. The particular form or furnace there figured seems to have been one adapted for heating a muffle and not arranged for a puddling furnace. On the other hand, in the arrangement shown in figures 1, 2, and 3, which is provided with a hearth, and is adapted for metallurgical purposes, there is no means shown of applying gas, but, on the contrary, fire-places in the furnaces are used. Now, in the patent of 1861 the advance is obviously not the mere combination of any Siemens regenerator with any means of producing gas, but I have regarded it as an advance in so much as it shows, or attempts to show, the combination of a gas producer, specially contrived for the purpose, with a number of differ-
76 ent forms of furnaces adapted to a variety of purposes. This was my meaning when I said, speaking of the furnaces of 1861, that "their construction was materially changed to adapt them to the advance already indicated and the wide range of capability flowing therefrom."

X 50 Question. Then are we to take it that you recognize in the Defendants' Exhibit Detmold Patent a combination with a regenerative system, however crude, with a gas producer for supplying

gaseous fuel to the furnace, and that you recognize in the Siemens patent of 1856 a regenerative system contemplating the use in combination therewith of gaseous fuel produced in or obtained from a separate place, and that this is the state of the art upon which the Siemens patent 167 of 1861 made its advance?

Answer. No, sir; not under that statement.

X 51 Question. You say in answer to question 6 that the construction of the furnaces as set forth in the patent of 1861 is, however, such as to adapt them for use in connection with gas fuel, said gas being generated in a separate producer, the construction of which is here specifically detailed, and you say in answer to cross question 46 that the Siemens patent of 1856 shows an arrangement of furnace in which it is stated that carburetted hydrogen or other inflammable gas may be used, which gas was to be made in a separate producer not shown; do you not recognize in the patent of 1856 the combination with a regenerative system of the use of gaseous fuel produced in a separate place?

Answer. I have said that the patent of 1856 shows a regenerative furnace of particular form and adaptation arranged to be used with gas obtained from an outside source.

X 52 Question. Are we to take it that you hold that the particular gas producer described in the English patent of 1861 is an essential part of the combination which you have specified in your answer 6 as one of the most important advances in the art?

Answer. Either that gas producer or some other one that contains the requisites stated in the patent of 1861. The patent says, "another part of our improvement consists in the particular arrangements of gas generators," and then goes on to set forth the requisites of the apparatus, and then the specific form of apparatus which I infer to be the best one known to the inventors.

77 X 53 Question. Do you understand that the operation of the regenerative system in the patent 167 of 1861 depends at all upon the particular form, construction, or operation of the gas producer therein described and shown?

Answer. The patent says, speaking of the gas producer: "The apparatus should be so arranged as to be very regular in its action, and to be easily freed from cinders from time to time. It is also important that the gas produced is not drawn through the furnace by the chimney, but that the full atmospheric pressure is maintained in the channels leading to the furnace, lest atmospheric air should be drawn in through crevices and produce a partial combustion of gas in the channel, which might be accompanied by a deposition of carbon in the same." The gas producer I understand to be suitably constructed to this end, and, therefore, upon its construction to this extent the operation of the regenerative system seems to depend.

X 54 Question. Is not the gas producer shown in the patent 167 of 1861 identically the same with that shown in the reissue 3265?

Answer. That appears to be the fact.

X 55 Question. Is not the literal description of the gas producer of the patent 167 of 1861 identical, word for word and letter for letter, with the description of the gas producer in reissue 3265?

Answer. No, sir.

X 56 Question. Are they substantially identical in the description of the gas producer? If they are not, point out any differences there are, if any.

Answer. The descriptions are substantially the same.

X 57 Question. If the operation of the furnace or regenerative system in the patent 3265 depends upon the construction and operation of the gas producer used in combination therewith, is there any indication of such interdependence in your exposition of the claims of the reissue in your answer to question 10?

Answer. I take it that the interdependence is to about the same extent as I have already pointed out in regard to the English patent 167. I stated, with regard to that patent, that the interdependence existed to the extent indicated between the regenerators shown and the gas producer shown, or some other gas producer capable
78 of meeting the same requirements. The inventors say the same thing, substantially, in their American reissue, as follows: "We do not confine our invention to the specific form or kind of gas generator, as there may be others which may be employed to good advantage, the whole depending on circumstances." Such interdependence as I have pointed out, based upon the arrangement of the gas regenerator, was, therefore, obviously not originally described in the American patent, and it therefore follows that I did not say so in my exposition above referred to.

X 58 Question. We must go back a little. In answer to question 4 you stated in reference to the English patent 2861 of 1856: "Broadly stated, the principle or mode of organization is this: After the products of combustion have done their work in the furnace chamber they are caused to pass over an extended surface," etc. Further on he says: "The construction of the furnaces, as set forth in the patent of 1861, is, however, such as to adapt them for use in connection with gas fuel, said gas being generated in a separate producer;" didn't you mean to imply in that answer that the patent of 1856 did not contemplate or was not such as to adapt it to use in connection with gas fuel, said gas being generated in a separate producer; if not, what do you mean when you say "the construction of the furnaces in the patent of 1861 is, however, such as to adapt them to use in connection with gas fuel," etc.?

Answer. If the counsel thinks there is any contradiction in those statements I should like to have it pointed out. As I knew what was set forth in the patent of 1856, and was quite well aware that it showed a regenerative furnace that could be worked by gas from an outside source, I certainly did not mean to imply directly the opposite of my knowledge; and as for what I meant by the last quotation, it speaks for itself, and states a simple fact, which is true. If I have misapprehended the meaning of the question, it needs further explanation.

X 59 Question. Well, to explain my misapprehension. What does this mean in your answer to question 6? "In the furnaces set forth in the patent of 1856 the construction is mainly such as to adapt them to the employment of solid fuel, and in that patent no

means of producing gas is described. In the patent of 1861 the combination of the gas producer with the regenerative furnace is distinctly shown; and while, as I have before stated, the furnaces of 1861 embody the same regenerative principle as the furnaces of 1856, their construction was materially changed to adapt them to the advance already indicated, and the wide range of capabilities flowing therefrom." Now, if the difference between the patent of 1856 and the patent of 1861 is that one proposes to use gas fuel without describing the producer or generator of that fuel, and the other proposes to use gas fuel and describes the producer, what difference is there between the two, so far as the combination of the gas producer with the regenerator is concerned, aside from the details of construction in the furnace or in the producer?

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Answer. I have, as it seems to me, now stated it three or four times, and I begin to despair of making myself plainer on the subject, that the patent of 1856 shows a regenerative furnace adapted to use gas taken from some outside source of production, which source of production is not shown, and that the patent of 1861 also shows a regenerative furnace which is adapted to use gas, which gas is taken from an outside source, and which source is shown. Now there can be no reasonable doubt that the mere bald fact of the combination of a regenerative furnace and an outside source of gas supply is indicated in the patent of 1856, and that it is shown in the patent of 1861.

(Adjourned to Wednesday, Nov. 29th, at 10 o'clock, a. m.)

(Examination resumed on Wednesday, Nov. 29th, 1882, at 10 o'clock a. m.)

Parties present as before.

X 60 Question. Coming now to the English patent 167, of 1861, do you not find described and shown in that patent a combination of a furnace and its chimney or smoke-discharge flue a system or series of air and gas regenerators, four in number, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace, and out of the chimney?

Answer. It will be noticed that in this question counsel has read the first claim of reissue 3265, leaving out the letters, the words "constructed substantially as specified," and the words, "in manner, and so as to be operated as and for the purposes herein described." I therefore understand that the combination named in the question is not the one set forth in the reissue 3265, but one independently framed by counsel, and with this explanation I answer that the elements named appear to be present in English patent 167.

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X 61 Question. Do you understand the words "constructed substantially as specified" in the first claim of the reissue 3265, as referring to anything but the regenerator B^1, B^2, B^3, and B^4?

Answer. I understand the words "constructed substantially as

specified" to refer to the construction of the regenerators, such construction being substantially as shown and being suitable to adapt them for use in the combination named.

X 62 Question. Do you not find in the English patent 167, described and shown, four regenerators constructed substantially as specified in the reissue 3265?

Answer. That will depend upon the meaning which may be attached to the term "constructed" in its connection in the first claim of the reissue when read in the light of the specification and drawing. If the expression be limited to this, for instance, "four air and gas regenerators constructed substantially as specified," then the qualification might be regarded as applying merely to the construction of any one individual regenerator. This will amount to inserting the word "each," in the foregoing expression before the word "constructed." Now, in that sense, inasmuch as the individual regenerator in the English patent of 1861 may be regarded as a chamber filled with bricks arranged in a particular way, such another chamber containing bricks arranged in like manner is shown in reissue 3265. But if the claim be read in this way, "a system or series of air and gas regenerators B^1, B^2, B^3, B^4, constructed substantially as specified in combination with furnace A, and its chimney or smoke discharge flue P," then I do not find the same system or series of regenerators in the English patent of 1861, as in reissue 3265, nor operating in the same manner; which of these two interpretations is the one to be adopted, I think, is more a question for the court than for me.

X 63 Question. You have seen fit to interject into my question, or into your understanding of it, more than I put there; will you answer the last question without adding to it? Question 60 repeated.

81 Answer. I understand the words to refer to a system or series of four regenerators in combination with a furnace and its chimney. To explain this a little further, the claim sets forth the series of four regenerators, two of which are air regenerators and two gas regenerators, also the furnace and chimney with which these are combined. Now a series of regenerators, four in number, may be arranged in different ways; thus the two gas regenerators may be placed between the two air regenerators, or the two air regenerators may be placed between the two gas regenerators, or air and gas regenerators may alternate, or the regenerators may be arranged in the manner shown in figure 13 of sheet 2 of English patent 167, or instead of having the air and gas regenerators placed as indicated in the last example, so that the pairs of air and gas regenerators are respectively arranged on opposite sides of a dividing line, they might be diagonally disposed in the parallelogram. These are all conceivable forms of construction of four regenerators, two gas and two air. Consequently when the claim says a series of four regenerators constructed substantially as specified, the question at once arises, what series out of, for example, those above mentioned by me, is to be combined with the furnace A, and the drawing shows that the construction of the series is such that the gas regenerators

are to be placed between the air regenerators; and that the combination of the furnace A with the series is such that the gas from the inner members of the series rises up and meets the furnace chamber under the air which rises from the outer members of the series.

X 64 Question. Does the first claim of the reissue 3265 specify the construction of the regenerators?

Answer. The claim separated entirely from specifications and drawings does not specify the construction of the series of regenerators or of an individual generator.

X 65 Question. Now if you will be good enough to dismiss the claim from your answer as I have done from my question, will you say whether there is anything specified in the reissue 3265 as to the construction of the regenerators which is not contained in the English patent 167, and if yea, what is it?

Answer. I have already pointed out very fully the differences in construction in the series of regenerators as set forth in combination with a furnace in both of the two patents referred to. The conclusions being arrived at from a fair interpretation not
82 of the specifications alone, nor of the drawings alone, nor of the first claim alone of reissue 3265, but of all taken together. This is the only way I know of finding out what is in a patent. Now, if it will please the counsel to have me take up the parts of the patent separately, and say what I find in each part, I will of course do so, and would suggest that unless he means me to consider the whole patent as I have done before by the use of the words, "anything specified in the reissue 3265," in the question, that he confine me in terms to the specification or the drawings or the claim, as he may choose, so that I may not misunderstand him.

X 66 Question. Can you answer my question as to any difference in the construction of the generators in the two patents without adding anything about the combination or arrangement of the series or system which my question does not refer to? If not, please say so, and do not wander into irrelevant answers.

Answer. If you know what you do mean, kindly explain to me this, in order that I may answer as intelligently as possible——

Counsel withdraws question.

WITNESS says: "I only wanted to know this from counsel, whether he is talking about the particular construction of an individual regenerator or of the series as set forth."

Counsel for defendants declines to be cross-examined upon his questions, and continues:

X 67 Question. In Appleton's Cyclopedia, referred to yesterday, page 186, volume II, I find, "the Siemens regenerative furnace, the regenerative system, invented by Dr. C. W. Siemens in 1862, may be generally described," etc. Do you know of any Siemens patent of 1862 on this regenerative system referred to in Appleton?

Answer. I cannot say; Dr. Siemens has taken out many patents on the subject. I don't know all their dates, but should have to

refer to a list which I have, but not here. I do not now specifically recall any particular one of that date.

X 68 Question. Have you examined any other of Siemens' patents except this reissue 3265 and the English patents of 1856 and 1861?

Answer. Yes, sir; a large number of them.

X 69 Question. Can you specify any of them?

83 Answer. Not in detail, except by referring to the digest of them which I prepared some time ago; generally, they related to various applications of regenerative furnaces, processes of steel and iron making, and to glass-making apparatus, and included a large number of descriptions of various contrivances, all of which it would be simply impossible to carry in my mind.

X 70 Question. In your answer to question 10 you state. "I see no trouble in making an operative regenerative furnace substantially as is shown in drawing attached to reissued letters patent 3265 which shall be operative as one regenerator," and you proceed to state how you would do that, saying: "Of course it would be advantageous to arrange a damper in one of the gas flues thus produced, so that all the products of combustion might be diverted through the single regenerator, but that damper is not essentially necessary, as the products of combustion might pass out through both the filled and the regenerative chambers." In that case would you not have two regenerators, one much better than the other?

Answer. I think not.

X 71 Question. In that case would the absorption of the heat from the outflowing gases and its transfer to the incoming gases be a continuous operation?

Answer. I am not sure that I understand the question, but the outflowing gases would heat that single regenerator, and then immediately after, upon reversing the current, the inflowing air would be heated by that regenerator.

X 72 Question. While the products of combustion are passing out of this one regenerator the influent air and gas which cannot at the same time pass through this regenerator would meet each other at their normal temperature, would they not?

Answer. Yes, about that. They would enter the furnace merely through the two of the empty passages from which I have supposed the bricks to be removed.

X 73 Question. During this time would not the cumulative feature of the regenerative system be wanting?

Answer. At that particular stage, yes.

X 74 Question. Then one-half of the time the furnace would be regenerative and during the other half not regenerative, would it not?

Answer. I don't know about that proportion of time exactly,

84 but the operation would be this, I think: Suppose the gas and air to come in through the two empty passages, they would be burnt in the furnace chamber, and the products of combustion would pass out through the other empty passage and the passage in which the bricks have been left; the bricks would then become

heated to some extent. Now on reversing the current the air would pass through the hot regenerative chamber and take heat from the bricks, and the gas would come through the empty chamber and mix with it, and the products of combustion would pass out through the two empty passages on the other side. I suppose the simplest way of expressing the difference between what happens when the current is turned one way or the other would be this: When the gas and air currents enter through the empty chambers they meet at about normal temperature, and when they enter through the regenerator and the other empty chamber, on mixing, the air is in a heated state and the gas is at normal temperature. The furnace may be said to be regenerating only on one side.

X 75 Question. What metallurgical or other purpose would such a furnace be applicable to or be available for?

Answer. That is hard to say; I have not considered that. The question with me was whether an operative furnace could be worked with one regenerator, and I pointed out how to do it. As for the uses to which it might be put, they may remain to be discovered. I believe an inventor is entitled to all the uses to which an appliance may be placed, whether he knows them or not; the degree of utility is not an essential to a patented contrivance so long as the latter is operative.

X 76 Question. Can you name any purpose or use for which such a furnace could be practically employed?

Answer. I cannot suggest now any use for which it could be advantageously employed. It might be practically employed for anything in the heating line when a low temperature is required. It would be operative all the same.

X 77 Question. Do you find in the reissue 3265 anythihg indicating, suggesting, describing, or showing one regenerator such as you have said you thought might be made operative?

Answer. Yes, sir.

X 78 Question. Point it out.

Answer. I quote: "In some cases, however, where no great
85 heat may be required, or when the gas may be very rich in combustible matter, the two regenerators for heating the combustible gases may be suppressed, and more passages substituted." That passage shows me that in a regenerative furnace where great heat is not required, the two gas regenerators are the ones to be suppressed; that leaves two air regenerators. Now, the last claim says: "We also claim the combination of a furnace with one or more regenerators * * * * and also with means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas." Obviously, when two air regenerators are used, as already pointed out in the quotation made from the specification, it is the air only which absorbs heat upon entering, and gives it off by leaving the furnace. The gas does not so act, or is not so acted upon. Heat is reduced by mingling hot air and cold gas, instead of hot air and hot gas. Now, supposing it is desired to reduce the heat still further. The only way to do this by regenerators is to suppress one or both; to suppress both leaves

the furnace not a regenerative furnace at all; to suppress one both reduces the heat and still leaves the furnace a regenerative furnace, using one regenerator, and this is what I understand to be set forth in the fourth claim. The reasoning which I have given is based solely on what I find in the specification, and nothing else, and I reach the conclusion entirely independently.

X 79 Question. Would the operation be, in your opinion, substantially the same with one regenerator as with four—I mean as a regenerative operation?

(Question objected to as to the words "regenerative operation" as indefinite.)

Answer. As I understand the question, the difference is only in a degree, and not substantial.

X 80 Question. Is it your opinion that the operation which you have described with one regenerator, the furnace being in that case only regenerative part of the time, is substantially the same as the operation with four regenerators, in which case the furnace is regenerative all the time?

Answer. Yes. The difference is only in degree, I think.

X 81 Question. Beyond the words in the fourth claim, do you find anything in the patent 3265 indicating or suggesting the suppression of three regenerators out of the four, and the use of one? If yea, point it out.

86 Answer. I do not find that the specification mentions the use of only one regenerator other than the claim aforesaid.

X 82 Question. In your answer to question 11 you have drawn a distinction between the patents 3265 and 167, in the respect that in 167 the gas and air enter the furnace side by side, while in the reissue 3265 the air enters above the gas; do you find in either patent any statement restricting the arrangement of the air and gas flues to the one or the other peculiarity mentioned?

Answer. Yes.

X 83 Question. Point it out.

Answer. I quote from reissue 3265. "Each of the said regenerators is arched or closed over at its top and opens into the furnace by a passage, *e*, leading out of it into a common passage, *f*, or *f'*, as shown in the drawings, the two passages *f f'* lead out of the furnace in opposite directions and from opposite ends thereof. The passages *e*, as shown in the drawings, to which, it will be noticed, the specification here specially refers, are so arranged, in connection with the passages *f* and *f'*, that the air must enter the furnace chamber above the gas, and in no other way, so that I am led to regard the construction of the furnace to be thus restricted, no other or different arrangement being particularly set forth. In English patent 167, with reference to the puddling furnace shown in figures 11, 12, and 13, between which form of furnace and that shown in No. 3265 I have drawn a comparison, I find this statement: "Thus, if gas in entering at the bottom of the regenerator C^3 and atmospheric air is entering at the bottom of the regenerator C^4 they become heated on passing through the masses of loosely-fitted bricks; arrived at

the top, they pass out through the passages J and K into the furnace through the side openings J′ and K′; here they unite, and on being ignited heat the furnace to the required extent," etc. The literal references to the drawing and examination of the latter show that the two columns of gas and air rise upward from the regenerator, meet and pass out side by side into the furnace chamber. No other arrangement of gas and air passages is shown or indicated in the figures referred to, and I, therefore, consider its construction to be limited and restricted to that which is shown and described.

87 X 84 Question. Do you consider the more intimate mixture of the gas and air by bringing the air in above the gas, as in the reissure 3265, as more than matter of degree compared with their mixture when brought in side by side as in English patent 167?

Answer. Yes, sir.

X 85 Question. Do you consider that difference so substantial that the question of infringement might depend upon it.

(Objected to as not cross-examination.)

Answer. I don't know quite how to answer the question. I don't think I understand it.

X 86 Question. Do you consider the difference you have mentioned of such substance that a furnace built according to the English patent 167, including the introduction of the gas side by side, would not include or contain the combination mentioned in the first claim of the reissue 3265?

(Same objection.)

Answer. Yes, sir.

(Adjourned to 2 o'clock p. m.)

(Examination resumed at 2 o'clock p. m.)

X 87 Question. Please examine figures 14, 15, and 16, on sheet 2, of English patent 167 of 1861, and state if you do not find in the operation of the brick-kiln, there shown in combination with the producer, that the air enters above the gas during a part of the operation, as described in the specification.

Answer. I understand the operation to be as follows: The gas pipe, marked B, leads into vertical shafts, marked D to D^4, each shaft is provided with two branch pipes, one indicated by *e*, leading into a vertical shaft arranged inside of the kiln, the other leading to a horizontal perforated pipe, which extends across the middle of the kiln. This arrangement is the same in each of the four regenerators. Now, the kilns being arranged, as shown in figure 14, the top of the kiln A^3 is left open, the air there enters, descends through the kiln A^3, passes from the bottom of the kiln A^3 into the upright shaft in kiln A^4, as indicated by the arrow, then down through A^4, along the passage *x*, up through the passage a^4 to the top of the kiln A^1,

88 down through that kiln, up through the shaft of the next kiln A^2, then down through that kiln and out by the passage G^2 to the chimney. Now, as to the gas, the branches indi-

cated by e to e^4 from the gas pipe are stated to open into the shafts a^1 to a^4 inside the kilns, so that it appears that when the air gets around to the vertical shaft a^4 in kiln A^1 it meets the gas coming into that shaft, mixes in that shaft, and the combustion takes place on the top portion of the kiln. In this way the top layers of the bricks become burned. Now, in order to burn the bricks equally throughout, it is necessary to have the place of highest temperature carried farther down into the kiln, and for this purpose the perforated pipes marked from F^1 to F^4 are led through the middle of the brick work. These pipes connect with the large branch pipes E, and when the small branch pipes e are closed the gas is admitted to these central pipes F, and escapes into the body of the brick work. There, of course, it meets the air entering into the upper portion of the kiln, and combustion follows. While, as a simple fact in this brick-kiln, at one stage of its operation the gas enters into the body of the brick work while the air is descending from the top, I do not regard this arrangement as in anywise similar or comparable to the construction whereby the air current is brought in above the gas current, as set forth in reissue 3265.

X 88 Question. You say in your answer to question 11: "The result of the arrangements of the current as adopted in reissue 3265 is the calling into play of a natural force which is not utilized for the purpose through the arrangement of currents shown in English patent 167, and that is the tendency of the air, by its own specific gravity, to settle down through the gas, and so mix with the latter;" now where does this appear in the reissue 2365 further than that the drawing shows the arrangement you refer to as bringing in the air above the gas?

Answer. The question suggests something which I should have added to my previous answer, which I should like to mention before proceeding further, and that is that in the brick-kiln referred to in my last answer it is the chimney draft which pulls the air down through and into the gas, and it is evident that this mixing does not occur merely by the sinking of the air into the gas by its specific gravity, as shown in reissue 3265, and as I have always testified as quoted in the question. The arrangement referred to in the
89 question is clearly shown in the drawing to which the specification particularly refers in describing the construction. The description of the construction is in the specification, and the drawing supplies the rest.

X 89 Question. Do you find in the reissue 3265 the statement that "the tendency of the air, by its own specific gravity," is to settle down through the gas, and so mix with the latter?

Answer. I don't find that statement in so many words. I do find that statement substantially set forth in the drawing and the description thereof.

X 90 Question. From what source did you derive the words of the statement quoted by me in the last question?

Answer. The wording is my own statement of the fact.

X 91 Question. Did you never see them elsewhere—those identical words in this connection, I mean?

Answer. It may be a case of unconscious plagiarism; but I don't know where I got them, if I did. I certainly repeated them just as they occurred to me here in testifying.

X 92 Question. Do you feel confident that you did not derive them from one of the Siemens patents?

Answer. Not to my knowledge.

X 93 Question. Wouldn't you think it a rather remarkable coincidence if you found those identical words in one of Siemens' patents, and a claim to this particular arrangement of the air and gas flues?

Answer. It would seem, and I can only account for it, if that is the fact, in this way: I have known for a long time, and did know before I had any knowledge of this case, that admitting the air above the gas into the furnace chamber was commonly regarded as one of the important general features of the Siemens regenerative furnace, and I know that in some of his later patents reference is made to this. Of course, in reading over other testimony in this case, or in some book which I may have taken up lately, I possibly may have met the form of words which I have used, which impressed themselves on my memory so that I unconsciously repeated them, but I am certain, at this particular moment, I have not the faintest idea that those exact words are to be found in any patent, nor, if such is the case, do I know in what patent they are.

X 94 Question. Would you expect to find those words, and such a claim as I have mentioned, in a patent issued thirteen
90 years after the date of the original of 3265, and as a reissue of an original patent five years later in date than the original of 3265?

Answer. If that is the case, the allowance of the claim by the Patent Office would be rather difficult to explain in the light of the state of the art as shown in 3265.

X 95 Question. Look at the certified copy now shown you of the reissued letters patent granted to C. William Siemens, of Westminster, England, reissue 7863, dated August 28, 1877, being a reissue of letters patent No. 89441, dated April 27, 1869, division B, for improvements in regenerative furnaces, and say if you find therein, "and I prefer to cause the air to enter the heating chamber above the gas, as by its superior specific gravity at equal temperatures it tends to sink through the gas, and thus an intimate mixture and more perfect combustion are obtained;" and in the claims of that patent do you find, "2d, a regenerative gas furnace, in which the gas is introduced at a level superior to that at which the gas enters as and for the purposes described"?

Answer. The question repeats the words of the patent. My statement of the fact was as follows: "The result of the arrangement of the currents as adopted in the reissue 3265 is the calling into play of a natural force which is not utilized for the purpose in the English patent 167, and that is the tendency of the air, by its own specific gravity, to settle down through the gas, and so mix with the latter, and this intermingling takes place over the whole width of the furnace bed, the conditions being substantially the same every-

where." I submit that this is not the identical wording repeated in the late patent, as it might be inferred I had used, from the preceding questions. I have stated a simple physical fact, which admits of little variation in the form of stating it. The patent appears to state substantially the same fact in its own way. There is not the smallest groundwork, which I can discover, for the indirect insinuation of counsel that I wittingly or unwittingly took my wording from the patent of 1877. I certainly did not do so, and I am not aware that I have ever seen that patent within the last year. The language quoted in the question is contained in the patent and specification referred to.

(Defendants' counsel offered in evidence the certified copy of the above-mentioned reissue No. 7863, and also a certified copy
91 of the reissue No. 7864 of the same tenor and date, being division C of the reissue of said original patent of 1869, to C. William Siemens, and will use the same at the hearing of this cause, as tending to contradict the construction put by the witness on reissue 3265; and he further requests complainants' counsel to admit upon the record that the said C. William Siemens, to whom the said reissues 7863 and 7864 were reissued, is the same C. William Siemens mentioned in the reissue 3265, and in the English patent 167 of 1861, and said copies are marked Siemens' Reissues, Nos. 7863, 1877, and 7864, 1877, C. F. Z., N. P., Nov. 29, 1882, respectively.)

(Complainants' counsel objects to the admission in evidence of said reissues Nos. 7863 and 7884, because defendants' counsel has no right to put in evidence any paper during the taking of complainants' evidence, and because the same is irrelevant, and will object to defendants' counsel in any way referring to these reissues, upon the hearing of this cause. Subject to these objections, they admit that the C. William Siemens, patentee named in said reissues, is one of the complainants herein.)

(Defendants' counsel withdraws the offer, but gives notice that he will renew it at the close of complainants' testimony.)

X 96 Question. You have said: "I do not see how any person skilled in the art could build a furnace with regulating valves by the aid of a mere allusion to the latter;" and yet you have said again that you see no trouble in making an operative regenerative furnace substantially as shown in reissued letters patent 3265, which shall be operative with one regenerator. Now, as there is not even an illusion in the reissued patent 3265 to a regenerative furnace with one regenerator, except the word "one" in the 4th claim, do you think that the allusion to the regulating valve in the English patent 167 affords less aid to one skilled in the art than the word "one" in the 4th claim of the reissue 3265?

Answer. To begin with, I didn't originally refer to the statements in the English patent, which Mr. Sellers thinks relate to gas and air regulating valves, as "an allusion." Mr. Sellers did that in his answer to cross-question 29. Second, the statement as to the use of one regenerator in 3265 is not an allusion; but there is a specific

claim (and a claim is one of the most important parts of a
92 specification) in reissue 3265 for that construction, and I have already explained that construction fully from knowledge derived from nothing but the patent itself, thus proving, at all events, that I could gain the necessary information from the patent.

Third. If the argument in the question is sound at all, it works both ways. If Mr. Sellers thinks the air and gas-regulating valves, which are neither shown nor mentioned in the English patent of 1861, and which I do not understand him to claim to be shown nor mentioned, except through the interpretation which he sees fit to place on the two short extracts which he quotes, and which extracts he refers to merely as an allusion, then it seems to me that the much more definite statement regarding the one regenerator in the American patent would be fully as good an, if not a better, allusion, wherefrom the furnace with one regenerator might be constructed. Besides, a person following the American patent would be guided by the whole specification, and not by the word "one" alone, or any other word or sentence taken out of its proper context.

X 97 Question. Do you hold that the English patent 167 does not sufficiently describe and show any regulating valves now?

Answer. I have fully explained that the English patent 167 does not set forth any air or gas regulating valve operating in like manner to produce like results as do the air and gas regulating valves fully shown and described in reissue 3265.

X 98 Question. Look at figure 15 of English patent 167, and say what the valves E^1 E^2 E^3 E^4 in pipes there shown are for.

Answer. The patent states as follows: "All these branches are provided with valves actuated by levers b^1 b^2 b^3 b^4, by means of which the gas can either be admitted through the passages a^1 a^2 a^3 a^4 into the top of a kiln, or through the branches E^1 E^2 E^3 E into the middle of the kiln, or the gas can be shut off from the kilns altogether." Therefore the valves referred to, serve to direct the gas into the top or middle of the kiln, as may be desired.

X 99 Question. Do not these valves, when closed, stop the flow of gas through the gas flue or passage in which they are placed?

Answer. Certainly; the foregoing quotation says so.

93 X 100 Question. When either of them is wide open, does it not permit a full flow of gas through the passage?

Answer. Yes.

X 101 Question. When either of them is partially opened will it not permit a diminished flow through the passage?

Answer. Yes; but the patent says nothing about using them in that way. The function ascribes to them a shutting off of the gas from one or the other branch of the pipe.

X 102 Question. Is not each of the levers which actuates those valves respectively provided with a sector which would indicate to one skilled in the art that the lever might be fixed at a point intermediate between the extremes of its moves?

Answer. Not at all; that assumption is wholly unwarranted.

X 103 Question. What are those sectors for under the levers b^1, b^2, b^3, b^4?

Answer. I presume they are intended to hold the valves either open or shut, although they furnish no positive evidence of this, as their surface appears to be wholly smooth from the drawing. To support the assumption made in the previous question it would be necessary for the sectors to show ratchet teeth or holes distributed along them, or some means by which the lever might be caused to engage with them at various points. The assumption that I have made that the sectors were made to hold the levers so that the valves either may be open or shut, accords best with the statement of the function of the valves set forth in the specification.

X 104 Question. If the sectors would hold the valves open or shut would they not hold them at an intermediate point?

Answer. No, sir; not necessarily at all. To infer that they hold it open or shut, I have to assume the existence of means by which the lever is enabled to engage with the sector at its outer ends, which means are not shown, but which assumption, as I have already pointed out, is nearest in accordance with the mode of operating the valves, as set forth.

X 105 Question. Would not the sectors hold the levers, respectively, by mere friction?

Answer. They probably would do so, if properly constructed for that purpose, until by use the adjacent parts of the sector and lever became worn. I don't find any such arrangement shown or
94 intimated in the drawing, and in the elevation of lever b^4 in figure 16, the sector seems to be omitted altogether.

X 106 Question. Would it not be within the skill of a constructor to make those levers hold the valves, respectively, partially open?

Answer. Undoubtedly. But there is absolutely nothing in the specification even suggesting the exercise of that skill, or even giving any reason why he should do so. I can hardly conceive of anybody applying contrivances to a device when there is nothing to indicate to him the necessity for their presence, or that they would serve any useful purpose. The inference from the specification is rather to the contrary, I think.

X 107 Question. Are these valves what you would call butterfly valves?

Answer. I have noticed that Mr. Sellers calls the reversing valves, which move on a central axis, "butterfly valves"; and if that term is correct, these are also butterfly valves. His definition of the term does not accord with the understanding of it I have hitherto had, my idea of a butterfly valve being a valve formed in two parts, each part being hinged to the central axis, so that the wings of the valve move somewhat analagously to the wings of a butterfly. Such valves have been used in pumps.

X 108 Question. Would you call these valves dampers?

Answer. Not, I think, in the strictest acceptance of the term, although they have the form of the ordinary damper, such as used in a stove-pipe. I understand a damper valve to be one placed in a conduit for completely cutting off or diminishing a fluid current;

this in contradistinction to a valve which is used to divert the passage of a current from one place to another.

X 109 Question. In your Appleton's Cyclopedia of Applied Mechanics I find this definition: "Damper, a valve placed in an air duct, by which the latter is opened or closed, more or less, in order to regulate the air supply and so increase or diminish the energy of combustion. Dampers are of various forms, usually in the shape of butterfly valves, hinged flaps, or sliding or rotating grates. They bear the same relation to the air pipe or flue as does the valve or faucet to the duct for steam or liquids." Is not that your definition, as there are no initials appended to it?

95 Answer. No; I think not. That article headed damper was taken out of one prepared by Mr. Buel on the steam boiler at the time the work was originally projected, it being the intention then for the article to cover a great many subjects which were afterwards separated. The initials at the end of the article, which should have appeared, are omitted, as they have been, inadvertently, in several cases throughout the book, chiefly because of the change in the original design, involving the splitting up of large articles, in many cases, into smaller ones. Moreover, I must decline to be held responsible for all the statements which may appear in two volumes, containing some 2,000 closely-printed pages. I was obliged to depend, in great measure, upon contributors, and I have no doubt that many errors have crept in, and that there are many statements that need modification or correction in case the work should be subjected to future revision.

X 110 Question. Do you repudiate the definition given in Appleton's Cyclopedia?

Answer. Not at all; I think it is right enough so far as it goes; but I think that the definition which I have given in a previous answer is the more correct one.

X 111 Question. Whatever you would call them, would not such valves as are shown in figure 15 of English patent, and of which we have been speaking, serve to regulate the flow of air and gas, as specified in the English patent—that is to say, with the utmost nicety?

Answer. They are not specified in the English patent to do anything of the kind. They do not serve to shut off or direct the air at all; they are in the gas ducts. If the valves shown were provided with means for holding them in any position, which they are not, and if you shut off one valve of the two shown, one in each branch of the gas-pipe, and open the other, more or less, then the gas supply would be more or less shut off, but, as I said before, there is no such arrangement as this set forth in the English patent of 1861.

X 112 Question. If similar valves were placed in the air channels they would similarly regulate the air, would they not, with all the qualifications you have annexed to the last answer?

Answer. That is too indefinite; in what air channels; how and where?

96 X 113 Question. We will leave that and return to the valves in figure 15 of English patent. Do you admit that they would close off the gas if they were shut?

Answer. Yes.

X 114 Question. Would they admit a full flow of gas if they were wide open?

Answer. Yes.

X 115 Question. And if partially open or partially closed, whichever you prefer, they would admit a partial flow of gas, would they?

Answer. Supposing you had some way to hold them in that position, they would, as I have already stated, shut off the gas more or less according as they are more or less open, but no such use or operation is suggested in the patent.

X 116 Question. Well, would it require any more skill or knowledge on the part of the operator to hold those valves partially open or to close them partially, whichever you prefer, than it would to operate the damper in a stove-pipe or to turn the faucet of a hydrant to an intermediate point?

Answer. It would certainly require no special skill to execute the performance of opening a valve anywhere more or less, but there is no reason shown or suggested in the patent why that skill should be exercised. The operator is told to use the valves to shut off gas to one or another part of the kiln, and that's all. I cannot discover anything which would suggest to him that any advantage was to be derived by arranging the valves other than as wholly open or wholly shut to accomplish the purpose specified. The very arrangement of the valves is based upon shifting the point of highest temperature from one part of the kiln to another in order to burn the bricks more thoroughly in all parts thereof. And I cannot conceive of anybody indulging in so stupid a proceeding as shutting off his supply of combustible partially and then shifting the reduced flame around the kiln.

PARK BENJAMIN.

Sworn and subscribed to before me, this 29th day of Nov., 1882.

CHARLES F. ZIEGLER,
Notary Public.

(Complainants close.)

97 EXHIBIT COMPLAINANTS' REISSUE LETTERS PATENT NO. 3265. C. F. Z., Sp. Ex., Nov. 28, 1881.

UNITED STATES PATENT OFFICE.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS, of Westminster, England.

Improved Regenerator Furnace for Metallurgists and Others.

Specification forming part of Letters Patent No. 41788, dated March 1, 1834; Reissue No. 3265, dated January 12, 1869.

To all persons to whom these presents shall come:

Be it known that we, Charles William Siemens and Frederick Siemens, residents of Great George street, Westminister, in or near the city of London, of the Kingdom of Great Britain, have made a

new and useful invention, having reference to furnaces of various kinds; and we do hereby declare the same to be fully described in the following specification, and represented in the accompanying drawings, of which—

Fig. 1 is top view; Fig. 2 a longitudinal section; Fig. 3 a transverse section; Fig. 4 a rear elevation, and Fig. 5 a front elevation of a puddling furnace, with our said invention applied to it; Fig. 6 is a longitudinal section taken through the air valves and passages of two outermost or air regenerators, to be hereinafter described; Fig 7 is a transverse section taken through one of the outermost re-generators.

The object of our invention is not only to economize heat, or to save and utilize much of it that is generallywasted by being allowed to escape into and through the chimney of a furnace, but to produce heat by the combustion of gases and atmospheric air in mixture, the gases being derived from coal or other fuel by furnace such as we shall hereafter ex-
98 plain or by any other suitable means or apparatus. In carrying out our invention in its application to a furnace for puddling iron, or for any other purpose, where the furnace is to be heated to a high degree, we arrange four of what we term the "regenerators" below the level of the bed of the furnace, and when all or any of them may be placed immediately underneath the furnace we form underneath the latter a space for the circulation of cold air, the top of the regenerator or regenerators which may be immediately underneath such space being duly covered. Passages lead from the upper part of two of these regenerators into the furnace, or into a channel or passage communicating with one end thereof. Similar passages lead from the two remaining regenerators, and in a similar manner communicate with the opposite end of the furnace. The lower parts of the four regenerators have passages leading into them respectively. To one of the regenerators of each pair, at either end of the furnace, the passage leading into its lower part is to open into the atmosphere so as to supply the regenerator with atmospheric air. The passage leading into the lower part of the other regenerator of the pair is a gas conduit for supplying its regenerator with gas. The several passages communicate with a flue or chimney, and have valves and reversing dampers, by means of which currents of air and combustible gas or gases may be directed through the furnace and the whole system of regenerators in the following manner: A current of air is to be caused to flow into the lower part and up through one of the regenerators of one of the two pairs of them. At the same time a current of gas is to be made to flow into the lower part of the other regenerator of such pair. After ascending through their regenerators, or between the bricks of the mass of loosely-piled brickwork or other refractory material making part of such regenerator, the said aerial and gaseous currents unite and flow into the furnace, where they are to be fired. The heated volatile products or spent gases resulting from the combustion of the said currents of air and gas will flow out of the furnace and into and down through the two remaining regenerators, and, after circulating through the masses of brick-

work or refractory material of which such regenerators are composed in part, the said spent products will be directed into and will
99 escape by the chimney. When the last two regenerators may have been sufficiently heated, the direction of the aerial and gaseous currents is to be reversed—that is to say, the currents of air and gas are to be caused to enter the two last-mentioned regenerators separately—that is to say, air is to pass into one and gas into the other. In ascending through the regenerators the air and gas will be heated, or will absorb from the masses of brick-work much of the heat previously imparted to them, after which the two currents will unite and flow into the furnace and there will be inflamed, and will produce a flame of very great intensity or heat. The spent products of combustion will flow out of the furnace and thence down through the remaining two regenerators, and after imparting their heat to them, or having it more or less abstracted by them, will be directed into and caused to escape by the chimney. The supplying aerial and gaseous currents are thus to be thrown though the pairs of regenerators alternately, their combustible products escaping through the discharging pair and serving to heat them, while they in turn serve to heat the aerial and gaseous currents when caused to flow through them.

Before proceeding to more fully describe our invention we will explain a gas generator such as may be employed in connection therewith, the said generator being shown in vertical section in Fig. 8. One or more of these generators may be used in connection with a conduit or conduits for the conveyance of gas to the regenerators. In this gas generator O is a hopper or induct, into and through which the coal or fuel is to be introduced, the said hopper being closed by means of a cover, *a*, after it may have received a supply of fuel. From the hopper the fuel descends an inclined plane, P, composed of fire-brick or other proper refractory or heat-resisting material, it being inclined at an angle of about forty-five degrees to the horizon. From thence the fuel passes upon a fire-grate, Q, having a less inclination. Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, there is an arch, R, of fire-brick. This arch, after having been heated to a considerable degree by the fire on the grate, will radiate heat on the fresh fuel while it may be passing down the plane, P, and thus will aid in causing the decomposition and volatilization of the fuel, which will be afterward completed by
100 the fire in the furnace and by the atmospheric air which may enter through the grate Q. The air, on passing through the highly-heated fuel lying upon the grate, will be decomposed into carbonic acid gas, with a certain proportion of nitrogen. Afterward, on passing up through the thick layer of fuel in a less state of combustion or incandescence, it will become transformed into carbonic oxide, and in this state will pass over the surface of the fuel, resting on the plane P, where it will mix with the gases evolved from the same, and finally escape by the passage S, and into the vertical pipe T leading into the conduit U, by which it will be conveyed to the regenerators. The aperture V at the top of the generator is to enable

a person to introduce a poker into the fuel for the purpose of stirring it from time to time. A valve, *w*, in the pipe T, answers to close the latter as occasion may require. By means of a pipe, *k*, leading into a conductor, *i*, water may be led into the generator in a small stream. This small current of water, falling on the fuel, becomes vaporized. The vapor, acting on any hot particles of carbon rising up with the gases, will combine with the same and form two combustible gases, viz, carbonic oxide and hydrogen.

We do not confine our invention to the employment of this specific form or kind of gas generator, as there may be others which may be employed to good advantage, the whole depending on circumstances. By means of the gas generator, or, in other words, by decomposing the solid fuel, such as coal, lignite, peat, &c., by means of a separate apparatus, we not only avoid the introduction of such fuel into the furnace, but we are enabled to heat the gas to a high degree, and to mix it with heated air preparatory to its being conducted into the furnace or place designed for its combustion, and to be heated thereby. By the absence of any solid carbon or ashes in the working chamber of the furnace operations may be carried on in an open furnace, which hitherto it has only been possible to conduct in covered vessels or pots. Thus we can melt flint, extra white, and other superior qualities of glass, in open pots, fire-pottery, without inclosing the same in "saggers," or melt steel and other substances upon an open bed or hearth without injury. It is also important in many operations that the state of pressure of the gases in the fur-
101 nace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmosphere in order to prevent the egress of flame from or the ingress of air into the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron. For this purpose we arrange with the furnace four regenerators, as hereinafter described, and to operate as before specified.

In some cases, however, where no great heat may be required, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four regenerators.

In applying our improvements to glass-furnaces we find it sometimes advantageous to melt the materials composing the glass in open pots, and to cover the latter with movable lids whilst working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces—for instance, to heat annealing furnaces or "lears" in the manufacture of glass—we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire-clay or other refractory material are to be provided in that case to these channels to regulate the flow of the gases, according to the direction in which the main furnace may be

working, or we draw off the mixed gases, in a state of combustion, from the principal furnace.

In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces, side by side, and only one set of four regenerators, which, by means of slides or valves of fire-clay or other proper refractory material, can be made to communicate at intervals with one heated furnace or the other. During the time that one furnace is fired the other is to be allowed to cool to be discharged,
and charged again with fresh material, and *vice versa*. The
102 regenerators may thus always be kept in working condition.
Or we arrange four or more chambers in such way that they themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns to be fired or discharged.

In the drawings, Figs. 1, 2, 3, 4, 5, 6, and 7, A is the furnace, of which *a* is the bed, and *b* the crown or arch, and *c* the mouth. Beneath the bed of the furnace are the four regenerators B^1 B^2 B^3 B^4, each consisting, in part of a chamber erected of firebrick or other suitable material, and having a grating, *c'*, extending across it lower part and constituting part of the upper portion of an arched passage H, I, K, or L, arranged underneath such chamber. Upon this grating a pile, *d*, of fire-bricks or other heat-absorbing and indestructible materials, the same being arranged or stacked in such manner as to leave interstices or spaces between them, so as to enable the air or gas, while passing through the pile, to come in contact with the surface of the several parts or bricks thereof. Each of the said regenerators is arched or close dover at its top and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or *f'*, as shown in the drawings. The two passages of *f f'* lead out of the furnace A in opposite directions and from opposite ends thereof. Directly underneath the bed of the furnace A, and between it and the tops of the two inner regenerators B^2 and B^3, there is an air-chamber or space C, which should communicate freely at its opposite sides or ends with the atmosphere, in order that a current of cool air may be caused to continually pass through it for the purpose of maintaining the bed of the furnace, as well as the arches of the regenerators B^2 B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators, while they may be in operation. In rear of the upper parts of the regenerators and below the furnace, there is an air space or chamber D, which, at intervals, is bridged, as shown at *g g g*. There is, also, below the space D a sunken space or chamber, E, in which are situated the levers for working the dampers of the apparatus. In front of the space E there is a passage, F, (see Fig. 6), which continues horizontally in opposite directions, and thence drops downward, and at its two extremities opens, respectively, into the two passages H and L, which extend under-
103 neath the two outermost regenerators. Each of these passages H I K L is to be closed at both of its ends, but the two mid-

dle passages I K are shown in Fig. 4 as open at their rear ends. These middle passages, however, with vertical continuations of them leading into a horizontal passage, N, are, as well as the said passage N, to be walled up or covered in rear. The same may be said with respect to a gas-tube or passage, O′, which is to lead from the generator and into the passage N, as shown in Figs. 3 and 4. Between the two passages I K there is a smoke-flue, P, into the rear part of which there is an opening, Q′, leading from the passage F, or a damper-case, R, arranged vertically therein, and having a damper, S′, arranged within it, and so as to be capable of being turned by a lever, *h*. There is another such damper-case, T′, applied in the passage N, and opening at its opposite sides into such passage, and also at its top into the generator-conduit or gas flue O′. Within the case T′ there is a damper U, capable of being turned by a lever, *i*. Situated over each of the damper-cases there is a valve-opening, V′ or W′, provided with a valve, X or Y, the whole being arranged as shown in Figs. 3 and 4.

By means of the damper U gas from the passage O′ may be led into either of the passages I K, it being cut off from passing into one while it may be passing into the other. So, by means of the damper S^1, air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other. The valve Y will serve to arrest the flowage of air into the passage F. So, with the valve X, it will answer to close off the passage of gas into the damper case immediately underneath it.

The operation of the said apparatus having been hereinbefore substantially described, we now proceed to point out what we claim as our invention—that is to say:

We claim, in combination with a furnace, A, and its chimney or smoke discharge flue P, a system or series of air and gas regenerators, B^1 B^2 B^3 B^4, constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace, and out of the chimney, in manner and so as to be operated as and for the purpose or purposes hereinbefore described.

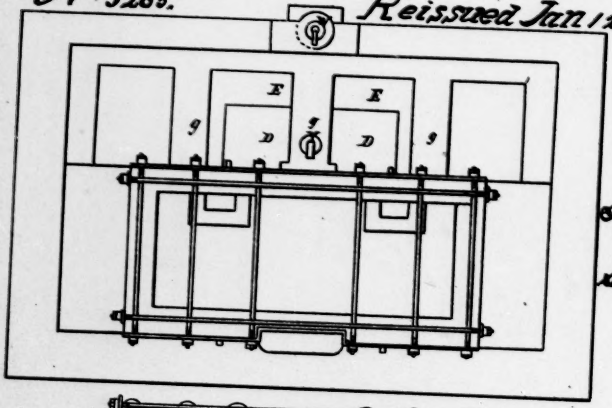
104 We also claim the arrangement and combination of the air space or open chamber C with the furnace and its system of regenartors, arranged and applied together, substantially in manner and so as to operate as described.

We also claim the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified.

We also claim the combination of a furnace with one or more regenerators or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom, and also with means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas

C. W. & F. Siemens Sheet 1. 4 Sheets. 5
Regenerator Furnace Fig. 1 1869

No. 3285. Reissued Jan 12



No 297.
Siemens & al. } p. 108
et.
Sellers & al.

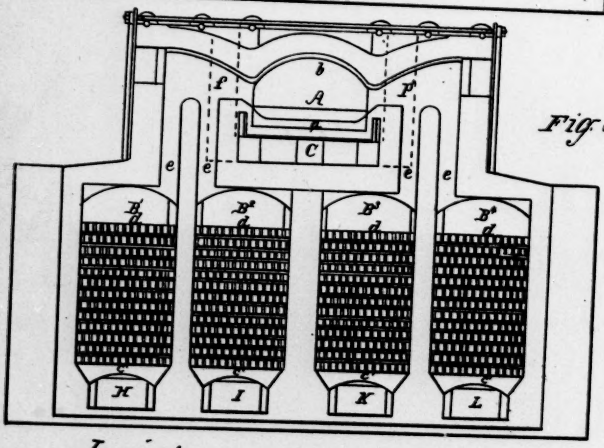


Fig. 2

Inventor.
Charles William Siemens
Trademaster Siemens
by their attorney
R. H. Eddy.

Witnesses.
F. P. Hale Jr
Frederick Curtis.

C. W. & F. Siemens.
Regenerator Furnace

Sheet 2 of 4 Sheets.
Reissued Jan. 12
Fig. 5. 1869

No. 297.
Siemens et al.
vs.
Sellers et al.
D. 106

No. 23205.

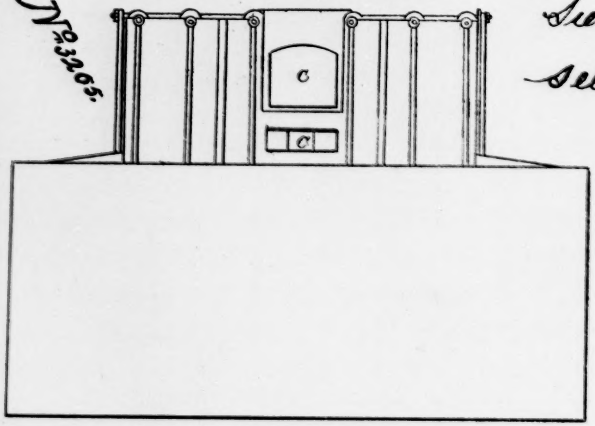
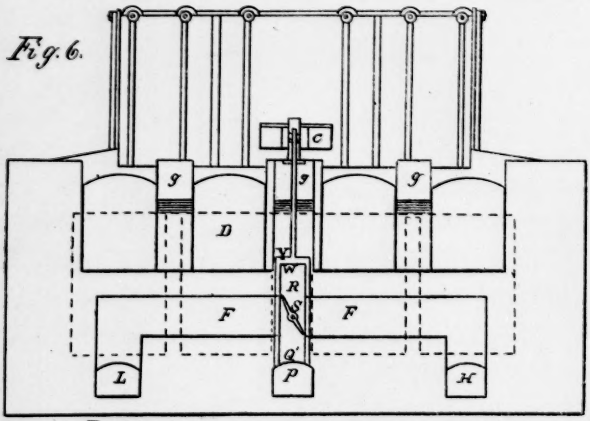


Fig. 6.



Inventor.
Charles William Siemens
Frederick Siemens
by their attorney
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Witnesses,
F. P. Hale Jr
Frederick Curtis.

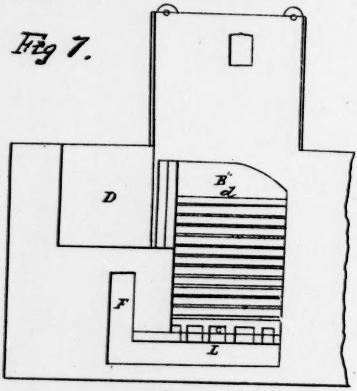
103

C. W. & F. Siemens. Sheet 1. 4 Sheets.

Regenerator Furnace.

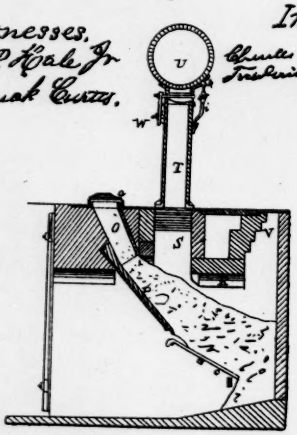
No. 3265. Reissued Jan. 12. 1869.

Fig 7.



No. 297
Siemens et al
vs
Sellers et al
p 105

Fig 8



Witnesses.
F. P. Hale Jr
Frederick Curtis.

Inventor.
Charles William Siemens
Frederick Siemens
by their attorney
R. H. Eddy.

during its passage into or to such furnace, for the purpose of improving or promoting combustion therein.

C. W. SIEMENS.
FRED. SIEMENS.

Witnesses as to C. W. Siemens—
EDW'D N. HOBBS,
THOS. TANNER,
Both of 2 Pope's-Head Alley, Cornhill, London, Gentlemen.

Witnesses as to Frederick Siemens—
OSWALD ROETHIG,
PAUL DRUCKMÜLLER.
Of Dresden.

(Here follow diagrams marked pp. 105, 106, 107, 108.)

109 (Second edition.)

(Coat-of-arms.)

A. D. 1856. No. 2861.

Specification of Frederic Siemens' Furnaces.

110 COMPLAINANTS' EXHIBIT FREDERICK SIEMENS' PATENT OF 1856. C. F. Z., Sp. Ex., Nov. 21, 1882.

(Second edition.)

PATENT	PATENT
18 A 6	17 6
One Shilling	Four Pence
67	67

(Coat-of-arms.)

A. D. 1856, 2nd December. No. 2861.

Furnaces.

Letters patent to FREDERIC SIEMENS, of 7 John St., Adelphi, London, engineer, for the invention of "improved arrangement of furnaces, which improvements are applicable in all cases where great heat is required."

Sealed the 27th day of January, 1857, and dated the 2nd Decem- 1856.

Provisional Specification left by the said Frederic Siemens at the Office of the Commissioner of Patents with his Petition on the 2d December, 1856.

I, Frederic Siemens, of 7 John street, Adelphi, London, engineer, do hereby declare the nature of the said invention for "improved

arrangement of furnaces, which improvements are applicable in all cases where great heat is required," to be as follows:

My improvement consists in so arranging smelting and heating furnaces, smith fires, etc., that the products of combustion, on their passage from their place of combustion to the stack or chimney, shall pass over an extended surface of brick, metal, or other suitable material, imparting heat thereto, which heat serves to heat the atmospheric air or other materials of combustion in such man-
111 ner that the cold air or gases are first brought into contact with the less heated material nearest the chimney, and is brought by degrees into contact with the more intensely heated portions, until it finally passes over that portion of the said surfaces nearest the place of combustion, and which are consequently heated to the highest degree. The result of this arrangement is that the air or other materials of combustion are nearly heated to the degree of temperature of the fire itself, in consequence whereof an almost unlimited accumulation of heat or intensity may be obtained.

The particular arrangements I adopt to carry my invention into effect are twofold: I either place the materials promiscuously into two air channels leading from the place of combustion, the opposite ends of these channels being connected alternately (in periods to be regulated according to circumstances and pleasure), the one to the chimney and the other to the atmosphere or a blast pipe or to gasometers, in case other materiels of combustion than atmospheric air are made use of. It will be perceived that in reversing the current from time to time by means of suitable valves, the materials placed into the two channels serve alternately to absorb the heat of the fire passing through it towards the chimney, and of heating the air or other gases on their way to the place of combustion. The channels so employed may be multiplied and placed in a variety of forms.

The second arrangement consists in arranging the two channels side by side, and connecting the one permanently with the chimney, and the other permanently with the atmosphere, blast pipe, or gasometer. The heat has to pass in this case through the partition dividing the two channels. The form and construction of these passages may also be varied *ad libitum* with a view of obtaining extended heated and heating surfaces.

Specification in Pursuance of the Conditions of the Letters Patent Filed by the said Frederic Siemens in the Great Seal Patent Office on the 2d June, 1857.

To all to whom these presents shall come, I, Frederic Siemens, of 7 John street, Adelphi, London, engineer, send Greeting:

112 Whereas Her Most Excellent Majesty Queen Victoria, by her letters patent, bearing date the second day of December, in the year of our Lord one thousand eight hundred and fifty-six, in the twentieth year of her reign, did, for herself, her heirs, and successors, give and grant unto me, the said Frederic Siemens, her special license that I, the said Frederic Siemens, my executors, administrators, and assigns or such others as I, the said Frederic Sie-

mens, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time, and at all times thereafter during the term therein expressed should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an invention for "improved arrangement of furnaces, which improvements are applicable in all cases where great heat is required," upon the condition (amongst others) that I, the said Frederic Siemens, my executors or administrators, by an instrument in writing under my, or their, or one of their hands, and seals should particularly describe and ascertain the nature of the said invention, and in what manner the same was to be performed, and cause the same to be filed in the great seal patent office within six calendar months next and immediately after the date of the said letters patent.

Now know ye, that I, the said Frederick Siemens, do hereby declare the nature of my said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement (that is to say):

My invention consists in certain arrangements of furnaces, which have for their object to recover the heat which is still contained in the flame or products of combustion on passing away from the fire-place, or heated chambers, or flues towards the chimney, by causing that heat or a great portion thereof to be imparted to the current or currents of atmospheric air, gas, or other materials employed to maintain combustion in the same or other fire-places, by which arrangements heat may be accumulated to an unlimited extent (consistent with the materials employed), and great economy of fuel is effected.

But in order that my invention may be more fully under-
113 stood and readily carried into effect, I will now describe the the best modes I am acquainted with of performing the same.

Sheet I represents a heating furnace according to my invention. Fig. 1 is a sectional plan of the same; Fig. 2 is a sectional elevation through the line A, B, in Fig. 1; Fig. 3 is a cross section through the line C, D, E, F, in the Fig. 1; Figs. 4, 5, & 6 represent the valve for changing the direction of the current on an enlarged scale. The furnace consists of the heating chamber P, with a door, *a*, which is separated from two hearths or fire-places, Q & Q^1, by fire bridges *c* & c^1. The fire-places are supplied with fuel through the openings *d* & d^1, which are closed by doors or shutters, *e* & e^1. *f* & f^1 are channels through which the cinders or ashes are removed, and which are easily closed by means of shutters or doors, *g* & g^1. Open passages, *h* & h^1, lead from the fire-places Q & Q^1 into the chambers R & R^1, which chambers contain fire brick or other refractory material, presenting large aggregate surfaces for absorbing heat, and which I propose to term "regenerators." Passages *i* & i^1 lead from the other extremities of the regenerators to the valve V and hence into the stack or chimney S. The valve consist- of a cast-iron casing, K, which is open at top and bottom and at two opposite sides; the two remaining closed sides are perforated in the middle to receive a spindle, *l*, upon which the valve plate *m* is fixed. The moveable valve plate

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mens, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time, and at all times thereafter during the term therein expressed should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an invention for "improved arrangement of furnaces, which improvements are applicable in all cases where great heat is required," upon the condition (amongst others) that I, the said Frederic Siemens, my executors or administrators, by an instrument in writing under my, or their, or one of their hands, and seals should particularly describe and ascertain the nature of the said invention, and in what manner the same was to be performed, and cause the same to be filed in the great seal patent office within six calendar months next and immediately after the date of the said letters patent.

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Sheet I represents a heating furnace according to my invention. Fig. 1 is a sectional plan of the same; Fig. 2 is a sectional elevation through the line A, B, in Fig. 1; Fig. 3 is a cross section through the line C, D, E, F, in the Fig. 1; Figs. 4, 5, & 6 represent the valve for changing the direction of the current on an enlarged scale. The furnace consists of the heating chamber P, with a door, *a*, which is separated from two hearths or fire-places, Q & Q^1, by fire bridges *c* & c^1. The fire-places are supplied with fuel through the openings *d* & d^1, which are closed by doors or shutters, *e* & e^1. *f* & f^1 are channels through which the cinders or ashes are removed, and which are easily closed by means of shutters or doors, *g* & g^1. Open passages, *h* & h^1, lead from the fire-places Q & Q^1 into the chambers R & R^1, which chambers contain fire brick or other refractory material, presenting large aggregate surfaces for absorbing heat, and which I propose to term "regenerators." Passages *i* & i^1 lead from the other extremities of the regenerators to the valve V and hence into the stack or chimney S. The valve consist- of a cast-iron casing, K, which is open at top and bottom and at two opposite sides; the two remaining closed sides are perforated in the middle to receive a spindle, *l*, upon which the valve plate *m* is fixed. The moveable valve plate

m is made to fit the valve casing K so as to intercept the direct passage of air upwards into the chimney when in either of its extreme positions, where it is retained by a tumbling weight, *p*, the lever *n* of which is keyed upon the spindle *l* and stands in the same angular position with the upper leaf of the valve plate *m*. It will therefore oblige the current of air entering from below to proceed in the direction of the arrows (see Fig. 4) through the passage e^1, the regenerator R^1, the fire-place Q^1, the heated chamber P, the fire-place Q, the regenerator R, and the passage *i* into the chimney S. By turning the valve *m* into the position as shewn by dotted lines (Fig 4) the direction of the current will be reversed, passing from without through the passage *i*, the regenerator R, the fire-place Q, the heated chamber P, the fire-place Q^1, the regenerator R^1 into the chimney S.

114 The regenerators are in this instance composed of walls of brickwork *r*, *r*, *r*, *r*, built in what is commonly called "open Flemish bond," so as to allow of a free passage through them. But it is important to observe that the holes or vacancies in the first wall are opposite to bricks in the second wall, and the vacancies of the second wall are opposite to bricks in the third wall, and so forth, the object being to break and divide the current at every step, and thereby cause a more perfect absorption of heat. The regenerators and fire-places are made easily accessible by holes in the side walls of the solid brick work, which are closed up with thin brick walls *o*, as will be seen from the drawing. When the valve stands in the position as shewn on the drawing, the current of fresh air, after passing through the regenerator R^1, impinges upon the fuel contained in the fire-place Q^1, and the flame produced by its combustion traverses chamber P and the empty fire-place Q, and reaches the extreme wall *r* of the regenerator R, which will be heated in consequence to a considerable degree. The second wall of the regenerator will be heated to a less degree, and the heat not absorbed by the same will pass on to the third wall, which will be still less heated, and so forth, each succeeding wall reducing the temperature of the heated currents of air to a less and less degree until it reaches the chimney comparatively cool. On reversing the position of the valve the cold air, entering the passage *i*, becomes heated by each succeeding wall of the regenerator R to a higher and higher degree, and it reaches the fire Q place nearly of the temperature of the flame in proceeding during the previous operation from the same fire-place into the regenerator R. The fire-place Q being now supplied with fuel will greatly enhance the temperature of the heated current by the ensuing combustion, and the hot flame so produced, in passing through the chamber P and fire-place Q, heats the first wall of the regenerator R^1 to the same increased degree of temperature. In passing through the regenerator R^1 the heat is successively taken up, and the current reaches the chimney comparatively cool. On reversing again the direction of the current the fresh air will be heated in its passage through the regenerator R^1 to a higher degree than before, and produce still hotter

flame by combustion of the fresh fuel which is now
115 being supplied to the fire-place Q^1, causing a further rise of temperature in the heated chamber P and the hotter extremity of the regenerator R. It will be perceived that in continuing to change the positions of the valve from time to time, and supplying the one and the other fire-place with fresh fuel, an unlimited accumulation of heat within the heated chamber P might be effected, which accumulation would be limited only by the fusion of the materials composing the furnace, or by loss of heat from external radiation. The temperature is, however, practically limited by the amount of cold material which is introduced from time to time into the heated chamber P through the door *a*, and may be regulated moreover by a damper upon the chimney in the usual manner.

Sheet II., Figs. 1, 2, & 3, represent another arrangement of my improved furnace, in which carburated hydrogen or other inflammable gas may be used instead of solid fuel.

Fig. 1 is a sectional elevation of the furnace and chimney; Fig. 2 is a cross section on line A, B, of Fig. 1; Fig. 3 is a sectional plan on line C, D, of Fig. 1. R & R^1 are the two regenerators, which in this case are composed of fire bricks, so arranged in upright chambers that there are zigzags or circuitous channels for the air through them; R^{11} is a broad channel between the two regenerators R & R^1 for the passage of the inflammable gas, which enters at the bottom through the pipe and regulating cock (*a*); P is the heated chamber, containing in this case a retort (*p*); V is the valve for directing the current of air through the furnace; and S, the stack or chimney. The valve V, which is represented separately in section by Fig. 4, Sheet II., consists in this instance of two flaps or plates *v* & v^1, suspended from hinges at their upper edge, and connected together by a rod *w*, which is jointed at both ends. The valve is worked to and fro by a rod, which may be connected to a lever with tumbling weight, or be held or secured by other means. It will be perceived that the chimney S will be put into communication with the passage *i* or i^1, according to the position of the valve, while the remaining passage *i* or i^1 will be open to to the atmosphere to admit the current of air to the furnace. The current of atmospheric air passes through the valve V in the direction of the arrows,
ascending through the regenerator R^1 into the chamber P,
116 where it meets the current of inflammable gas ascending through R^{11}, and combustion having saken place, the heated products descend through the regenerator R into the chimney S. On reversing the position of the valve V the current of air passing upwards through the regenerator R will reach the chamber P in a highly-heated condition and meet the inflammable gas, which, during its ascent through the heated passage R^{11}, has also been considerably raised in temperature by heat conducted from the regenerators through the walls of the passage R^{11}. The surface exposed to the inflammable gas during its ascent may be further increased by horizontal partitions in the passage R^{11}, producing zigzag passages for the gas, and heating the same, in a similar manner to the air passing through the regenerator R, though to a less degree. The passage

R^{11} may be divided longitudinally, and a valve may be applied to pass the current of fresh gas alternately through the one passage or the other, so as to meet the current of hot air in the heated chamber P ascending on the one side or other. The second passage R may be at the same time traversed by the returning current of the products of combustion, and form a pair of regenerators of its own. The passage R^{11} may be made to supply also solid materials of combustion to the chamber P, which materials would in that case also reach the place of combustion in a heated state. It would be preferable in that case to construct the regenerators horizontally, or even in the inverted position to that shewn, making R^{11} a hopper. In such cases, where the reversing of the currents may be attended with inconvenience, and where the attainment of the highest degree of heat or economy of fuel is less essential, I adopt an arrangement of furnaces, as represented by Figs. 5, 6, and 7, sheet II. Fig. 6 represents a sectional plan of this variety of my improved furnace; Fig. 7 represents a sectional elevation of the same on line A B C D of the plan; and Fig. 5 is a sectional elevation on line F G in Figs. 6 & 7. It consists of two sets of passages R R R and R^1 R^1 R^1 R^1. The passages R are open on one side to the atmosphere, and on the other side to the heated chamber P. The remaining passages R^1 are open at one end to the chamber P through the passages *h*, *h*, *h*, *h*, and at the other extremity to the chimney S. The direction of the currents, which are con-
117 tinuous, is indicated by arrows. All the passages R & R^1, which together act, to some extent, the part of the pair of regenerators in the arrangements before described, are contrived in such a manner that the currents pass in a zigzag or tortuous way through them for the better absorption of heat, which is being transmitted continuously from the heated products of combustion passing through the channels R^1 in one direction to the currents of air or other gas passing through the channel R in the opposite direction, by conduction through the walls dividing the two sets of channels or passages. The heated chamber P is made in this instance to contain the coke or other fuel being supplied from above, and is retained laterally in its position on one side by the blocks *c c c c*, forming an upright grating, and on the other side by the pots or crucibles *p p p p*, which also act the part of a grating. It will be readily perceived that nearly a complete entrechange of temperatures between the products of combustion and the fresh air or gas supporting combustion in the same or any other fire-place could be effected in this way, provided only the walls or partitions dividing the passages offered no impediment to the transmission of heat through them, and resisted at the same time the action of the heated currents. The partitions may be advantageously made of metal plate so arranged as to form zigzag or tortuous channels. Instead of retaining the fuel between the upright gratings *c c*, or between pots, it may be disposed upon a solid hearth, as before described in reference to Sheet I. On the other hand I sometimes employ upright or sloping gratings of fire-brick or stone, or gratings formed of pots or crucibles, to retain the fuel when regenerators worked by periodic reversion of currents are used.

My improved furnaces may be varied in form and construction to suit different applications and purposes. The regenerators in particular may be constructed of different materials, which may be either thrown promiscuously into chambers or passages, or may be built up so as to form zigzag or even straight passages for the heating and heated currents. The fuel may be exposed to the action of the heated currents upon solid hearths, or upon and between gratings formed of refractory materials, either by itself or in the same chamber with the crucibles, or of other materials to be heated, melted, or
118 converted. One of several fire-places may be used for heating one chamber, or one fire-place may be arranged between two chambers to be heated alternately, and forming, in point of fact, part of regenerators. The chamber or chambers so heated may be varied in form to contain the substances or objects to be heated, which may be pieces of metals, or crucibles containing metals, glass, or other substances. It may be made to contain gas or other retorts, pottery wares, metallic ores, either separate or mixed with fuel, lime, brick, or other materials to be baked or heated. The heated chamber may also be so arranged as to form the flues of boilers, pans, or stills for the evaporation of liquids; and one of the advantages of the application of my invention is, that smaller heating surfaces than at present required will suffice to evaporate a given quantity of liquid, owing to the greater intensity of heat that may be maintained throughout, besides which the smoke of the fire will be consumed on its passage through the regenerator, and a considerable economy of fuel be effected. The saving of fuel I effect by my improved furnace becomes more important, however, according to the degree of temperature required to be obtained, being greatest of all in melting cast steel and refining metals, and in other cases involving the necessity of intense heat. Instead of producing the currents of air and of the products of combustion by means of a chimney or chimneys, artificial means, such as fans or blowing cylinders, may be resorted to, particularly for the purpose of smelting iron or other metals, the ores of which may be made to fill the heated chamber completely, and may or may not be mixed with the fuel supporting combustion. Care must be taken in that case to close the sides of the furnace in a proper and efficient manner.

My invention may also be rendered applicable to stoves and fire places of every description. The arrangements of the valves employed for changing the direction of the currents may also be varied to suit particular purposes, and one or more chimneys may be employed in connection with them.

Having now described the nature of my invention, and in what manner the same is to be performed, I wish it to be under-
119 stood that I do not confine myself to the details or particular combinations of parts described in reference to the drawings, for the same are susceptible of great variation.

I do not claim generally the alternate passing currents of air of different temperatures in opposite directions through the same apparatus so as to effect an interchange of heat, as I am aware that

arrangements of that nature have been adopted for heating and cooling air and steam for working engines; nor do I claim generally the heating of atmospheric air or other materials to support combustion by the heat produced during combustion, or the valves or other details hereinbefore described, when separately considered; but what I claim is—

1stly. Constructing furnaces in such a manner that the heat of the products of combustion is abstracted by passing the same through chambers containing refractory materials so arranged as to present extensive heat-absorbing surfaces, and is communicated to currents of air or other gases by passing the latter currents alternately over the same heated surfaces.

2ndly. Constructing furnaces in such manner that the products of combustion and currents of fresh air, or other gases destined to support combustion, are directed at intervals in opposite, or nearly opposite, directions through chambers containing refractory materials, so arranged as to present extensive surfaces, with a view of effecting an exchange of temperatures between the two alternate currents.

3rdly. Arranging two chambers containing materials presenting extensive surfaces in connection with one furnace containing one or more fire-places, in such manner that, while the material contained in one chamber are being heated by the current or currents containing the products of combustion, the heated materials in the second chamber impart heat to the current or currents of air or other gases intended to maintain combustion, and *vice versa* the heating and heated currents being passed alternately through each of the chambers in opposite directions.

4th. Arranging a valve or valves in connection with furnaces in such a manner that, by changing the position of the same from time to time, the current or currents of air and heated gases in the furnace and chamber or chambers containing heated materials are reversed in their direction, but are made to enter and issue without interruption through the same apertures, so that they may be impelled by one chimney or blowing apparatus.

5thly. Arranging two or more pairs or sets of chambers containing refractory materials, and which I have termed "regenerators," in relation to one furnace and one or more fire-places, in such a manner that, while one pair of regenerators serves to transfer the heat of one heated current to a current of fresh air supporting combustion, a second pair of regenerators may be employed to impart heat to the carburetted hydrogen, carbonic oxide, or other gaseous material, intended to enter into combination with the heated air produced by the first-mentioned pair of regenerators.

6thly. Constructing furnaces with two or more regenerators so arranged as to be traversed alternately in opposite directions by the products of combustion and the air employed to support the combustion, and at the same time to communicate heat by conduction to the gas or fuel which passes from the cool end to the hot end of the regenerators through a separate passage or passages, and thence

into the fire-place or combustion chamber of the furnace, as hereinbefore described in reference to Figs. 1, 2, & 3, sheet II.

7thly. Constructing furnaces with a series of zig-zag or tortuous passages for the entrance of continuous currents of air or gases for maintaining combustion, which currents are heated by the products of combustion passing in the opposite direction through another series of passages, alternating with the above-said passages, and divided from them by thin walls or partitions, through which the heat is transmitted in the manner hereinbefore described in reference to figures 5, 6, & 7, sheet II.

In witness whereof I, the said Frederic Siemens, have hereunto set my hand and seal this second day of June, one thousand eight hundred and fifty-seven.

FREDERIC SIEMENS. (L. S.)

121 *Depositions on Behalf of Defendants.*

United States Circuit Court, Eastern District of Pennsylvania. In Equity. Oct. Sess., 1880.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS *vs.* WILLIAM SELLERS *et als.* } No. 8.

Depositions of witnesses on behalf of defendants, taken, sworn, or affirmed to and reduced to writing by and before Charles F. Ziegler, a notary public for the Commonwealth of Pennsylvainia, residing in the city of Philadelphia, at the office of Messrs. Baldwin, Hollingsworth, and Fraley, No. 714 Walnut street, Philadelphia, on Wednesday, March 29th, 1882, at eleven o'clock, a. m., and pursuant to adjournments.

Present: Henry Baldwin, Jr., Esq., counsel for defendants; Charles S. Whitman, Esq., and Silas W. Pettit, Esq., counsel for complainants.

It is agreed between counsel for the respective parties that "blue book" copies of specifications and drawings of English letters patent shall be *prima facie* evidence of the fact of the granting of such letters patent, and of the date and contents thereof, without being certified by the Patent Office or otherwise formally proved, with the same effect as if such copies were certified under section 893 of Revised Statutes.

Counsel for defendants offers and puts in evidence a certified copy from the Patent Office of the letters patent granted C. W. and F. Siemens, dated March 1, 1864, No. 41788, for improved re-
122 generator furnaces, being the original letters patent of which Complainants' Exhibit Reissue 3265 is a reissue, and the same is marked "Defendant's Exhibit Complainant's Original American Patent, C. F. Z., Sp. Ex., March 29, 1882."

Defendants offer and put in evidence a certified copy from the Patent Office of file wrapper and contents in the matter of the letters patent granted Cnarles W. & Frederick Siemens, March 1, 1864,

No. 41788, for improved regenerator furnaces, and the same is marked "Defendants' Exhibit Complainants' Application for Original American Patent, C. F. Z., Sp. Ex., March 29, 1882."

Defendants offer and put in evidence a certified copy from the Patent Office of file wrapper and contents in the matter of the reissued letters patent granted to Charles William Siemens and Frederick Siemens, dated January 12, 1869, No. 3265, for improved regenerator furnace for metallurgist and others, and the same is marked "defendants' exhibit complainants' application for reissue, No. 3265, C. F. Z., Sp. Ex., March 29, 1882."

Defendants offer and put in evidence, under the above stipulation as to such copies, a blue book copy of the English letters patent No. 167, dated the 22d of January, 1861, sealed the 19th of July, 1861, to Charles William Siemens and Frederick Siemens for improvements in furnaces, and the same is marked "Defendants' Exhibit Complainants' English Patent of 1861, C. F. Z., Sp. Ex., March 29 1882," and complainants' counsel admit that the patentees in said English patent named are the complainants in this cause.

Counsel for complainants objects to the offering in evidence of the "Defendants' Exhibit Complainants' Patent of 1861," on the ground that it is immaterial, in that it does not describe or claim the invention described and claimed in the patent upon which this suit is brought.

COLEMAN SELLERS, a witness on behalf of respondents, being first duly affirmed according to law, deposes and says in response to interrogatories proposed to him by Mr. BALDWIN, counsel for respondents:

123 1 Question. What is your name, age, residence, and occupation?

Answer. Coleman Sellers; I am fifty-three years of age last January; I reside in Philadelphia; I am a mechanical engineer, and am at present a member of the firm of William Sellers & Co., Philadelphia, engineers and machinists.

2 Question. Please state whether you have any familiarity with the manufacture of iron and steel, the appliances used in such manufacture; with the inventions and improvements therein for some years past; with patents for such inventions and improvements; whether you have been in the habit of examining such patents; the extent of your general acquaintance with the arts and sciences, and what positions you have occupied in scientific bodies, and whether you have heretofore testified as [an] expert upon scientific questions in patent causes.

Answer. In the year 1846 I entered into the service of the Globe rolling-mill, in the city of Cincinnati, Ohio, learning all that pertains to the manufacture of iron as practised in rolling-mills in those days, and ending in being superintendent of the establishment. From this I turned my attention to the manufacture of locomotives, and for a number of years was foreman of the Niles Locomotive Works, in the city of Cincinnati. In 1856 I removed to

Philadelphia to take the position of chief engineer of the establishment of William Sellers and Company, where I have continued either as an employee or as a member of said firm ever since. In my connection with the firm of William Sellers and Company I have had constantly to watch and study the progress of the arts in the direction of the manufacture of iron and steel, and also have had to design much of the machinery employed therein. I have conducted the preparation of very many applications for patents, taken out both in this country and abroad, and have had constant calls upon my faculty of observation and discrimination as relating to inventions and the method of securing the inventors' right therein, being myself an inventor, and having taken out many patents, both in my own name and conjointly with others. During my whole life, as above exemplified, I have had close communication with scientific societies. During the time of my residence in Cincinnati I was one of the directors of the Ohio Mechanics' Institute; have been for many years a member of the Franklin Institute of the State of Pennsylvania for the promotion of
124 mechanic art, and am now a member of the board of managers of the said institution, and occupy the chair as professor of mechanics. I was for a number of terms president of the same institution. I am a member of the American Philosophical Society; of the Academy of Natural Sciences, of the city of Philadelphia; the American Society of Civil Engineers; ex-vice-president of the American Society of Mechanical Engineers; associate member of the American Railway Master Mechanics' Association; corresponding member of the Society of Arts, in Geneva; and in 1867 received from the King of Sweeden knighthood in the Royal Norwegian Order of Saint Olaf.

I have frequently been called upon to act as expert in cases in which patents were involved, and have at all times made patent investigations an essential part of my studies.

3 Question. Have you read and examined Defendants' Exhibit Complainants' English patent of 1861, and do you understand the contents of that patent?

(Objected to by Mr. Whitman on the ground that the English patent referred to is immaterial.)

Answer. I have read and I do understand the patent referred to.

4 Question. Have you read and examined Complainants' Exhibit Reissue Letters Patent No. 3265, and do you understand the specification and drawings of that patent?

Answer. I have read and examined the patent referred to, and do understand the specification and drawings.

5 Question. Please compare the specifications and drawings of Defendants' Exhibit Complainants' English Patent of 1861 with the specification and drawings of Complainants' Exhibit Reissue Letters Patent No. 3265, and state how far you find what is described and shown in said reissue No. 3265 described or shown or comprised in said English patent of 1861, giving your reasons for such opinion as you may express, and dealing with the subject-matter of the several claims in the reissue 3265 respectively.

(Objected to as immaterial.)

Answer. I have examined the two patents in question, and while I do not find the drawings attached to the American patent to be identical with any of the many forms of furnaces figured in the English patent, yet I do find the subject-matter and scope of
125 the American patent is comprised in the English patent, the two patents being in many essential particulars worded alike; the English patent not having any specified claims, but terminating with the assertion that "we claim as our invention the various arrangements of regenerative furnaces worked by the gases resulting from an imperfect combustion of solid fuel in separate places as hereinbefore set forth," while in the American patent, conformably to the custom prescribed by the American laws, four specific claims are made. In reference to the drawings, I wish to observe, that the producer figured in figure 8 of the American patent is identical with figure 5, on sheet 1, of the English patent.

The drawings attached to the American patent relate to a furnace for puddling iron, and are used to illustrate the object of the invention and its mode of operation, and cannot be construed in any way as confining the claims to the particular use and purpose for which such a furnace has been designed. Inasmuch as American patents, especially at the time at which this application was made, were to be accompanied by a model, such drawings and such model agreeing in all particulars, therefore it has been customary for inventors to select any one of the many uses to which their patent may be applied, as is most convenient for illustration by model and drawings within the space or bulk prescribed by the Patent Office rules as regulating these essentials to a perfect application. In the American patent the inventors describe clearly the principles involved not only in the puddling furnace as figured, but allude at length to other uses to which their invention is to be applied, all involving the essential features of such invention. This may be clearly explained by reference to their claims, the substance of which I now give, but omitting letters of reference, thereby in my answer showing my appreciation of the merit of the invention and its general scope as claimed by the inventors. Thus they claim a furnace with a chimney or smoke-discharging flue, a system or series of air and gas regenerators constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be let into and through such regenerators and furnace and out of the chimney in manner so as to be operated as and for the purpose hereinbefore described. This, the first claim that they make, covers clearly and distinctly the essential features of their very remarkable inven-
126 tion, as it is described and figured in the English patent above referred to, the specification preceding this claim in the American patent being worded in a similar manner to the specification embodied in the English patent.

The second claim of the American patent is for the combination of an air space or open chamber with the furnace, and its system of regenerators arranged and applied together, substantially in man-

ner and so as to operate as described. This very important claim has reference, as is clearly shown both in the English and American patents above referred to, to the protection of the bed or the hearth of the furnace when such furnace is placed directly over the regenerative system. This open chamber is lettered C in the American patent, and shown in various drawings, but most clearly, for the purpose to which I allude, in figure 2 of sheet 1 of the American patent, and fully shown in figure 2, sheet 2, of the English patent, and there lettered with a small *a*. The value of this invention is clearly set forth in both patents, and is for the purpose of protecting the bottom of the hearth and the crown of the arches of the regenerative systems placed immediately below. As the inventors state, it is for the passage of cool air through space C, or the space *a* in the drawing referred to in the English patent, or in spaces *e* and *f* of figure 8, sheet 1, of English patent, or of space *e* in figure 10, sheet 2, English patent, to prevent the cumulative action of the heat, which, in long-continued use of the furnace, would ultimately end in the destruction of the same.

The third claim of the American patent refers to the arrangement and combination of a certain air chamber or space, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified. This claim has reference to another very important part of the invention, as shown in the American patent, and as clearly shown in the drawings and specifications of the English patent above referred to. The primary and essential feature of the Messrs. Siemens' invention lies in the use of chambers loosely filled with refractory material, through which the incoming gas and air pass on their way to the furnace, and in other similar chambers loosely filled with refractory material, through which the outgoing products of the combustion which has occurred in the furnace pass on their way to the chimney. This outgoing heated matter imparts its heat, or a portion of it, to the refractory material in the chambers above referred to, which, after a time, obtains
127 a considerable degree of heat, when upon the reversal of certain valves or dampers the incoming gases are made to flow through the thus heated chambers, while the outgo begins at once to reheat the chambers which previously had formed the passageway for the incoming gases. The incoming gases becoming heated in their passage to the furnace, but gradually carrying off heat from the materials loosely filling the chambers, it therefore becomes essential that there should be periodical reversals of the direction of the flow of the gases alternately through the two sets of chambers, and for this purpose a system of valves is necessary. It is also essential that the quantity of gaseous fuel and of air admitted to the furnace be regulated with nicety, in order to effect an object dwelt upon at quite sufficient length both in the American specification and in the English patent above referred to. In the English patent on page 2, lines 37 to 39, it is stated that dampers are provided, in the cold air and gas channels, by which the quantity and quality of the flame can be regulated to the utmost nicety. The use of these valves is set forth very clearly in English specification, page 5, be-

ginning at line 30 to line 36 of the same, and in the American patent in the following words: "It is also important in many operations that the state of the pressure of the gases in the furnace should be under entire control, and should at some times exceed and at other times exactly balance that of the atmosphere, in order to prevent the egress of flame from, or the ingress of air into, the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron;" to which I will also add, it is essential in practice to regulate the proportion of incoming gas and air in order to obtain an oxidizing or a non-oxidizing flame if desired. Claim third of the American patent refers to that portion of the furnace system that involves the arrangement of valves for the purpose specified, those valves being very clearly shown in figure 3 of sheet 2, of the American patent, the valve for the admission of gas being lettered X, that for the admission of air being lettered Y; with the exception of these two valves or dampers, the remaining parts of all the devices needed for the successful working of the Siemens process of double regeneration is shown and described in the same manner in the English patent already referred to and in the American patent. As I have already stated, the
128 functional use of these dampers or valves, which I have alluded to as X and Y, has been fully shown in the English specification as essential to the invention, but they have in no case been figured in their drawings. A careful examination of the drawings appended to the American patent indicates that in selection of the peculiar type of furnace adopted to illustrate the essential features of the invention one of a pair of twin furnaces has been so selected, for it becomes only necessary to reverse a drawing of figure 3 against itself, placing it in such a manner that arch N shall come in contact with arch N, completing the perfect arch, and then will be seen a perfect system of two furnaces fed from one gas conduit end, having within this archway N duplicate sets of valves and dampers, while the air is admitted to the two separate systems through two distinct chambers equivalent to that marked D in figure 3. This chamber D is in free communication with the open air, being only arched over at intervals, as is shown in figure 6 of American patent, and marked with *g* at those arches. A deeper portion of this opening D, marked E in American patent, is a recess in which the levers of the reversing valves are situated. These reversing valves are shown clearly and distinctly in the American patent, where they are respectively lettered U for the gas and S for the air reversal. These reversing valves are essential to the working of the Siemens regenerative system, and are shown in sheet 1 of the English patent, in figure 3, where that for the gas is indicated by the letter *g*, that for air by the letter *h*. On this drawing the space corresponding with E, figure 3 of the American patent, is not lettered, but is indicated as immediately below the two letters Z, which are the reversing levers. On sheet 2 of the English patent, figures 11 and 13, these two valves are indicated by, on 11, letter D, on 13, by letters D and E, while this space E in American patent is clearly shown in figures 11 and 13 of English patent, but not lettered, so

that there is no part of the mechanism covered by the third claim of the American patent which is not found described or illustrated in the above-mentioned English patent, and even more fully shown in its various modifications on the English drawings than in the one illustration used with the American patent.

In reference to the fourth claim of the American patent, if the words "one or more" be stricken out, then the remaining por-
129 tion of this claim clearly relates to and covers what is claimed in the other three claims; but inasmuch as the term "one or more" is used, a careful examination must be made and has been made by me, not only of the American patent to which it appertains, but also of the English patent already referred to; and in this connection I may say that I have been familiar with the operation and the theory of the Messrs. Siemens' very remarkable invention from its beginning. I am aware that other patents exist prior to the English patent above referred to, in which a recuperative process forms an essential feature, but neither in the American patent now under consideration nor in the English patent to which I have continually referred, nor in any other one of the Messrs. Siemens' patents which have come under my notice, issued prior to the date of the American patent, can I find any instruction or description which would enable one skilled in the art to make a regenerative system in which one regenerator such as is described and shown in the English patent 167 of 1861, or in the American patent reissue No. 3265, can be made to receive the waste smoke and gaseous products, can be made to intercept and receive heat therefrom, nor can I find any means or devices whereby all or a portion of the heat so intercepted and received may be absorbed by the influent air or gas during its passage into or to such furnace for the purpose of improving or promoting combustion therein. The Messrs. Siemens in their English patent above referred to, on page 6, beginning at line 8 and ending at line 11, and also in American patent, allude in almost the same words to the possibility of using two generators in place of four, but not showing any use of one regenerator. These passages I quote, first from the American specification and then from the English, to show the similarity of the wording. In the American patent they say: "In some cases, however, where no great heat may be required, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four generators." In English patent above referred to, line 8, as stated, I find: "In some cases, where no great heat is required or where the gas used is very rich in combustible matter the two regenerators intended to heat the combustible gases may be suppressed and mere passages substituted, but we generally prefer the four regenerator arrange-
130 ment," the similarity of language in the two patents differing only in punctuation and the terminal word of the last sentence. It is essential in the working of the Siemens regenerator that at least two chambers be provided. These chambers as they fully describe, are loosely filled with refractory material; the incom-

ing gas or air, passing through the interstices of the matter filling one of these chambers, abstracts from such material any heat that may have been stored up in it, while the outgoing products of combustion from the furnace, in passing through the remaining chamber, imparts its heat to the loosely filling material in that chamber, fitting it to be used in turn as the regenerator of incoming gas or air. This is in fact the thoroughly well-known principle of the so-called Siemens regenerative system. To conceive of the use of one regenerator, as applied either to air or to gas, and standing in place of the two regenerators which it has been said in the patents referred to may be used in place of four, is clearly incompatible with a regenerator constructed in the manner described in either of the two patents under consideration, which regenerators, being mere chambers filled with loosely arranged refractory material, are not fitted in any way to allow the incoming air or gas to pass through that regenerator and to receive heat therefrom, while at the same time the heated products of combustion are passing through the same mass of refractory material and imparting its heat to the same. Thus it seems evident to me that the term "one or more regenerators" does not apply to anything in the American patent to which it is affixed, nor to the English patent to which I have referred, as I can find no words that would enable one skilled in the art to construct such a regenerator. In both English patent and American patent I have already alluded to the similarity of the drawings illustrating the so-called producer, figure 8 of the American patent, figure 5, sheet 1, of the English patent, the lettering on these being identical, and the word description of the two being almost identical. There is scarcely a part of the American patent, other than that which describes the peculiar furnace taken as an example, but what seems to have been extracted bodily from the English patent above referred to, nor do I find any portion of the American patent, save and except its fourth claim, but what might be as aptly illustrated by the drawings of the English patent. Nor do I find
131 anything in the American patent which would enable one skilled in the art to construct a puddling furnace, or any other furnace, in which the regenerative system can be used in any better or more thorough manner than by a consultation or reference to the English patent before referred to, while on the other hand the English patent does, by means of its many illustrations, give a rather more comprehensive description of all that is contained in the American patent, save and except the fourth claim of the American patent so far as it refers to one generator.

Adjourned to Wednesday, April 5, 1882, at 11 o'clock a. m.

Examination resumed Wednesday, April 5, 1882, at eleven o'clock a. m.

Counsel present as before.

6 Question. In the English patent of complainants, No. 167, of 1861, do you find any equivalent for or of the air chamber or space D, or the same and the space E, combined with the furnace, regen-

erators, conduits, and damper chests applied thereto, substantially as specified in the reissue 3265, and referred to in the third claim thereof? If so, please point out the same in said English patent.

Answer. In the American patent the description of the functions of chamber D contains in said description the assertion that there exists within such chamber a damper case, R, arranged vertically, and having a damper, S', arranged within it so as to be capable of being turned by lever H. Referring to sheet 2 of English patent above referred to, No. 167, figure 11, shows a damper case, marked D in this drawing, and having its damper, D, capable of being turned by a lever, *d*. Above the valve D, or damper case containing valve D, there is an arched space equivalent to the chamber D in the American patent, whilst the reversing lever *d* is situated in a chamber extending below the one just alluded to, and being equivalent to that portion of the American patent drawings where such space is indicated by letter E. Again, in sheet 1 of English patent No. 167, in figure 3, this space, equivalent to D in Amer-
132 ican patent is indicated by the letter I. It is shown to be arched over in the drawing, and serves the same purpose of containing the damper case and admitting air to the damper case marked *h*, the valve of which is operated by a lever, Z, in a space equivalent to E in the American patent drawings, and being arranged for the same purpose. In this drawing that I is in free communication with the atmospheric air is not only indicated in the description of the drawing, but the passages *e*, equivalent to passages C in the American drawing, and designed to allow free passage of air between the bed of the furnace and the crown of the arches of the regenerator, are shown to be in communication with this chamber I.

Cross-examined by Mr. WHITMAN:

X 7 Question. Having reference to your answer to the last interterrogatory of the direct examination, will you be kind enough to state how the outer air or atmosphere reaches the space I in figure 3 of sheet 1 of the English patent 167 of 1861?

Answer. It reaches it, so far as the description in the specification is concerned, through small channels marked *e e e*, communicating at one end, through the channel *f*, with the atmosphere, and at the other end with the air passage I, conducting to the regenerators. A current of cold air is continually passing through these channels, tending to maintain the bed of the furnace and the arches covering the regenerators at a low temperature.

X 8 Question. The outer air or atmosphere in passing through the channels *f* and *e*, and before reaching the space I, would become heated, would it not, by the combustion within the furnace?

Answer. It would become heated by the passage of heat through the bottom of the furnace and through the crown of the arches, said heat the result of the combustion in the furnace.

X 9 Question. On becoming thus heated the air, according to well-known physical laws, would rise into the outer atmosphere unless

some counteracting force would prevent it from so doing, would it not?

Answer. It would.

X 10 Question. When the furnace shown in figure 3, sheet
133 1, of the English patent is in operation, would there be any counteracting force which would prevent the air in channels *f* and *e* from rising into the outer atmosphere?

Answer. If chamber I is closed over by a solid arch and has no other communication with the air save and except through channels *e*, such arch would prevent it rising; but whether it is so entirely closed or not I am unable to state with certainty from the drawings.

X 11 Question. According to the construction shown in said figure 3 of the English patent, does the air which flows through the air regenerator flow also through the passages marked *f* and *e*?

Answer. If there be no other opening into I for the admission of air than the openings *e*, then all the air which enters I must have passed through channels *e*.

X 12 Question. Is there not, then, this difference between United States patent No. 3265, reissue, and the English patent No. 167; that is to say, that in the English patent the air for cooling the bed of the furnace is drawn downward through the passages *f* and *e* into the chamber I, and from thence to the air regenerator, whereas in the United States patent referred to the air passes upward from the cooling chamber C through chimneys, top of which is clearly shown in plan in figure 1, and by dotted lines in figures 2 and 3?

Answer. There is this difference between the furnaces figured to exemplify the two patents: In the American patent the principles of the invention are illustrated by reference to a puddling furnace, in which the passages C beneath the hearth of the furnace are made to communicate with two chimneys or upward passages through the body of the furnace proper and at the back side of said furnace; while figure 3, sheet 1, of the English patent 167, being one of many examples figured as illustrative of the principles involved in the invention, shows a furnace to be used in the manufacture of glass, and in this one illustration the chamber I is closed presumably, and the air, warmed by passage through *f* and *e*, is thus utilized.

X 13 Question. How is the air thus utilized?

Answer. By being passed through damper-chest H into the regenerative system of the furnace.

X 14 Question. Is there not this difference between English patent No. 167 and United States reissue 3265, that in the former
134 patent there is no cooling chamber beneath the bed of the furnace, all the parts of which communicate with each other in such a manner as to allow the air to pass freely about and around the under side of the furnace bed, whereas in the English patent three or more separate chambers or passages are shown below the bed of the furnace, such chambers not communicating with each other?

Answer. Before answering this question I will have to ask for an explanation of the passages to which reference is made "as not communicating one with the other."

(Counsel for complainants having pointed out the passages referred to as *e* in figure 3 of the English patent as being *a* in figure 11 of English patent, and as being C in American patent, witness answers:)

There is a difference in the arrangement of the passages in the examples given in illustration of the English patent to the extent of the passages in the English patent being continuous across and under the bed of the furnace, while in the example given in the American patent these passages are crossed by other passages to permit the more free circulation of the air under the bed of the furnace.

X 15 Question. Is there not also this difference between the United States and English patents, concerning which you have just testified: that in the United States patent the gas-regenerative chambers are arranged in the space between the air-regenerative chambers, and the air-regenerative chambers are arranged on the outside of the gas-regenerative chambers, whereas in the English patent the gas-regenerative chambers are not arranged in the space between the air-regenerative chambers?

Answer. In the American patent the example taken in illustration shows the gas-regenerative chambers to be between the two air-regenerative chambers, while in figure 3 of the English patent the glass furnace there illustrated is so arranged as to utilize the outer regenerative chambers for gas and the inner regenerative chambers for the air, while in figure 13 of the English patent, sheet 2, the grouping is quite different.

X 16 Question. Is there not also this difference between the American and English patents referred to in your last answer:
135 that is to say, that in the American patent a mixing or common chamber is arranged above the point where the air and gas enter for combustion, whereas in the English patent no mixing or common chamber is shown arranged above the point where the gas and air enter the furnace?

Answer. In the American patent each of the said regenerators is arched or closed over at its top, and opens into the furnace by a passage, *e*, leading out of it into a common passage, *f* and *f'*, and I wish to know if this common passage *f* or *f'* is the mixing chamber alluded to.

(Mr. WHITMAN says, "I allude to the passage *f* and *f'*.")

In the figure 3 of English patent, sheet 1, being a glass furnace, as before stated, the air and gas are discharged directly from the mouths of their passages leading out of the regenerators into the body of the furnace, while in figures 11 and 12, puddling-furnace, the gases pass into a common chamber above the ends of the two passages from the regenerators, and there being mixed as shown by the arrows, pass by or through a passage marked *b* to the furnace. I see no essential difference between the two examples cited, namely, figures 11 and 12 of the English patent and the American patent.

X 17 Question. In figures 11 and 12 of the English patent, if the mixing chamber or common passage is situated above the ends of the two passages from the regenerators, will you be kind enough to state how far above the tops of the ends of the passages the common passage or mixing chamber is situated?

Answer. In the English patent, figures 11 and 12, end views of the flues or passages seem to be indicated by two diagonally-crossed lines, this being one of the conventionals used in drawing for that purpose. Now, in figure 12, spaces marked J, K, L, M are so indicated by diagonal lines crossing from opposite corners of the square, while in figure 11 of the same patent the spaces marked J′ and L are so marked; these last two spaces thus marked J′ and L seem to indicate, inasmuch as the arrows lead out of them, the turning over of the upward flues into a mixing-chamber, the bottom of which chamber is therefore on a level with the top of the flues J, K, L, M, but in the bottom of said mixing-chamber there is shown a narrow channel, N O, through which any overflow of cinder or metal
136 may occur without danger of its flowing down J, K, L, or M into the regenerator. The mixing-chamber I believe to be the whole of the rectangular space bounded by the outer sides of J, K, L, or M, and to be immediately above or on a level with the top of the flues J, K, L, M.

X 18 Question. Do you find the channel through which any overflow of cinder or metal may flow, of which you speak in your last answer, shown or described in the United States patent, C. W. and F. Siemens, of which you have just testified?

Answer. I do not find any such passage.

X 19 Question. Does not this difference exist between the United States and English patent; that is to say, that in the United States patent the gas rises into the mixing chamber in front of the air and between the air flue and the point where metallurgical and other operations are conducted in the furnace, whereas in the English patent no such construction is shown?

Answer. In the example taken to illustrate the American patent gas does rise into the mixing chamber in front of the air, while it does not so enter in any of the examples shown in the English patent.

X 20 Question. Does not this difference also exist between the United States and English patent; that is to say, that in the United States patent the air regenerators are not arranged immediately below the bed of the furnace, whereas in the English patent the air regenerators are either wholly or partially immediately below the bed of the furnace?

Answer. There is the difference thus stated between the examples cited.

X 21 Question. Does not this difference also exist between the United States and English patent—that in the English patent the reversing valves or dampers are square, whereas in the United States patent they are oval?

Answer. The damper chests shown in the English patent are rec-

tangular, while the damper-chests in the American patent are circular.

X 22 Question. Does not this difference also exist between the United States and English patents referred to—that in the United States patent the partition walls between the air and gas regenerators extend vertically upward and form the division walls between the air and gas flues, whereas no such construction is shown in the English patent?

Answer. The walls in question do extend up as specified.

137 From the position of the regenerators in the example cited in the English patent such construction is not possible.

X 23 Question. Does not, also, this difference exist between the English and American patents above referred to—that the partition wall between the regenerative chambers and the partition wall separating the air and gas flues are in the same vertical plane in the United States patent, whereas no such construction is shown or described in the English patent?

Answer. They are on the same vertical plane in the American patent, and they do not appear to be on the same vertical plane in the example cited in the English patent.

X 24 Question. Does not this difference also exist between the English patent and the United States patent referred to—that is to say, that in the United States patent a direct communication exists between the air-chamber below the bed of the furnace and the outer atmosphere, as shown more particularly in figure 5 of the United States patent at the point marked C, whereas no such construction is shown in the English patent?

Answer. I do not consider that this difference exists, inasmuch as in figure 11, the only vertical section of a puddling furnace shown in the English patent, the passage-ways, equivalent to C in the American patent, are marked *a*, and I see no reason to infer that they do not continue across the furnace, and have openings at their outer ends to permit the free passage of air, inasmuch as—I quote from the English specification—" below the bed, spaces *a*, *a*, *a*, are provided for the circulation of cold air." I cannot conceive of the circulation of cold air without their being some place where the cold air can get into the spaces.

X 25 Question. Does not this difference exist between the American and English patents referred to—that is to say, that in the American patent there is a space, E, arranged immediately below and communicating with the space D, whereas in the English patent there is no communication between a space, E, and the space D immediately above it?

Answer. In the American patent, in the example taken to illustrate it, the spaces E and D do communicate; in the drawings attached to the English patent there is no indication to show that the spaces, equivalent to D and E, of the English patent do communicate one with the other.

138 X 26 Question. Does not this difference also exist between the United States and English patents referred to—that is to say, that in the United States patent there are tubular damper-

cases having oval dampers arranged within them, whereas in the English patent the damper-cases are not tubular nor are the dampers of oval form?

Answer. The damper-cases figured in both sets of drawings, namely, those attached to the American patent and the various examples shown in the English patent referred to, are in both cases tubular. In one case, the American patent, the tubes are cylindrical in form, and in the other case they are rectangular in form, each having the dampers made to conform to the shape of the tubes.

X 27 Question. In your answer to question 5, in one place you say, "I do not find the drawings attached to the American patent to be identical with any of the many forms figured in the English patent;" in another place you say, "I wish to observe that the producer found in figure 8 of the American patent is identical with figure 5 of sheet 1 of English patent;" do you mean by these statements that figure 8 of the American patent is the only figure therein which is identical with the figure in the English patent?

Answer. I mean to say that the producer is the only part of the apparatus figured alike in both patents.

X 28 Question. In investigating the patents of C. W. & F. Siemens, have you discovered that the producer to which you have referred in your last answer has formed the subject-matter of a United States patent not involved in this suit or mentioned in the bill of complaint of complainants?

Answer. I have made no investigation into any of the patents which may involve a producer as separate and distinct from the regenerative system of the Messrs. Siemens. I do not find the producer mentioned in the claims appended to the American patent No. 3265.

X 29 Question. In your answer to question 5 you state that in the English patent it is stated that dampers are provided in the cold air and gas channels; do you refer here to a statement in the specification filed in pursuance of the conditions of the English letters patent, or to a statement contained in the provisional specification.

Answer. I allude to both. In the provisional specification
139 are found the words, "Dampers are provided in the cold air and gas channels, by which the quantity and the quality of the flame can be regulated with the utmost nicety," while in the main body of the specification, page 6, line 4, occur the words, "causing a plenum of pressure within the same, which is capable of being modified or regulated by valves for the admission of gas and air to the regenerators," so that in both the provisional specification and in the complete specification I find allusion to regulating valves. The valves in the damper cases, and which turn back and forth to deflect the currents towards or from the respective regenerators, being themselves valves, and known in the trade or art as "a butterfly valve," no matter what may be their external form, cannot be construed into valves regulating pressure, placed and used as they are both in the American and English patent drawings. Hence I obtain from the English specification the information that valves to regulate the admission of air and gas to the regenerators in the sense of regulat-

ing quantity are essential to the successful working of the Messrs. Siemens patent.

X 30 Question. Does not the American patent referred to differ from the English patent referred to in this: that in the American patent is shown a gas-regulating valve, X, which may be worked independently of air-regulating valve Y; that is to say, when the air is allowed to flow into the furnace by one valve the gas may be wholly or partially shut off by the other, whereas in the English patent referred to no valve for regulating the inflow of gas is shown or described as being worked independently of the valve governing the inflow of air?

Answer. As already stated in my answer to question 5 of my examination, the valves for the regulation of the gas and air mentioned in the complete English specification as being there for the purpose of the admission of gas and air to the regenerators are figured as X and Y in the American patent, and are there shown as being capable of being worked separately, while in the English patent above referred to, while they are not figured or shown, but merely described as necessary, I cannot find any intimation that they are to be worked conjointly, nor do I know how it would be possible to work them conjointly to regulate the quantity and quality of the flame.

X 31 Question. Will you be good enough to examine Eng-
140 lish drawing and state for what purpose the damper marked *w* in figure 3 is used?

Answer. The drawing, figure 3 of the English patent, shows a glass furnace, and also shows, in connection with this glass furnace and its system of regenerators, two producers, both of them partially in section, the one marked J K having its section made through the centre of the pipe which carries or conveys the carbonic oxide gas from the producer to a horizontal chamber, U, placed above it, from which chamber U the gas passes to the regenerator. In the vertical pipe leading from the producer the specification of the English patent says that valves *w*, which is the valve pointed out as the one in question, are provided in the pipes T of each gas generator, so as to shut off the communication with any one of them when not in use or under repair.

X 32 Question. Might not the valve *w* be used to regulate the flow of gas to the regenerator?

Answer. It might with certainty, provided only one furnace be operated from that producer, or if several furnaces are operated from the same producer, that the regulation be the same for all the furnaces.

X 33 Question. You have stated that you are a member of the firm of William Sellers and Company. Is the Mr. William Sellers referred to one of the defendants in this suit?

Answer. He is.

Adjourned to Thursday, April 6, 1882, at eleven a. m.

Examination resumed Thursday, April 6, 1882, at eleven o'clock a. m.

Counsel present as before.

X 34 Question. Does not this difference exist between the United States reissue patent and the English patent heretofore referred to: that a mixing chamber, into which the air enters behind the gas, is shown in the puddling furnace illustrated and described in the United States patent, whereas in the English patent no construction is shown or described whereby the air may be made to enter
141 the mixing chamber behind the gas; that is to say, in such a manner that the air enters between the gas-port and the point in the furnace where metallurgical operations take place?

Answer. In the examples cited and figured in the American patent, and claimed to represent a puddling-furnace, the air enters the mixing-chamber behind the entrance-passage for the gas, as stated in the question, while in the example given in illustration of the English patent, both in that of the glass-furnace, figures Nos. 1, 2, 3, and 4, and in the puddling-furnace, figures 11 and 12, the gas and air enter through passages which may be considered as being side by side instead of one back of the other; therefore in this construction the heated gas and air mingle, approaching each other from opposite sides of the mixing-chamber, figured in Nos. 11 and 12, and thence proceed into the furnace, whilst in the example cited in the English patent, as representing the process used in applying the regenerative system to kilns for burning bricks, and alluded to in the specification forming part of the American patent in the following terms: "Or we arrange four or more chambers in such a way that they themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns to be fired or discharged," we find that the gas from the producer is made to enter a space, figured F^1 F^2 F^4, representing channels or spaces in the midst of the material to be fired, and in the direction of the currents through which the products of the combustion are made to pass through the series, the air heated by having been already passed through a previously fired chamber, which chamber is described as the regenerator of the air to the next succeeding chamber being fired; the air is made to enter above the point of entrance of the gas, F^1 F^2 F^4, but clearly behind it, so far as the direction of the currents are concerned in the passage through the chamber being fired, through the entire series.

X 35 Question. In your examination of the English patent referred to, have you discovered that a disclaimer had been filed regarding certain portions of the English patent?

Answer. I have had no such disclaimer presented to my attention for my examination. I know of no such disclaimer.

X 36 Question. Does not this difference also exist between the United States patent and the English patent referred to: that the American patent shows four regenerators adjacent to each
142 other and in the same direction, and also exhibits means whereby the air and gas, after passing the regenerators, pass vertically upward into the mixing chamber, whereas in figure 1 of

the English patent the air and gas passages, leading from the four regenerators, arranged in the same direction, are not vertical?

Answer. Before answering this question I wish to have explained to me, in order that I may answer intelligently, what is meant by four regenerators adjacent to each other and in the same direction.

(Mr. WHITMAN states that he means that a vertical plane passed through the four regenerators at any point between the front and back thereof would cut vertically all the regenerators; that by the term adjacent I mean that the regenerative chambers are arranged side by side and adjoining each other, except that the necessary mason work is of course interposed between them.)

Witness answers: In the example cited as illustrating a glass furnace in the English patent four regenerators are shown as situated side by side, arranged so as to be substantially in the same position one with the other as are those shown in reference to the furnace figured as illustrating the American patent, but inasmuch as the bed or hearth of the glass furnace, upon which rest the eight melting pots X, is very large as compared to the horizontal area of the regenerative chambers placed beneath it, and, in fact, extends entirely over the entire set of four regenerators; the passages from these regenerators to the point where they enter the furnace, as shown by i' and i in figure 1, (which i in the specification and in reference to figure 2 indicates dividing walls between certain channels, D^1, D^2, D^3, etc., but which in this case I use as pointing out a locality upon the drawing), are tortuous and not straight, while in the example cited for the puddling furnace in the English patent, where the regenerators are adjacent one to another and beneath the bed of the furnace, but not in line in the sense implied in the question, the passages from the regenerators to the mixing chamber are vertical.

X 37 Question. Does not this difference also exist between the United States and the English patent referred to—that in the United States patent the distances travelled by the air and gas through the regenerators and the gas passages to the point where they
143 enter the mixing chamber are practically the same, whereas in figure 1 of the English patent, where a similar system of regenerators is shown, the distances are not the same?

Answer. I would like to ask from whence it is considered that the gas or air start in the estimate of the distance they travel relatively one to the other before I can answer the question?

(Mr. Whitman replies: "From the base of the regenerators.")

Witness answers: My answer is that in the drawing referred to as figure 1, in the English patent, the distance traveled by the air is greater than that travelled by the gas, inasmuch as the wide, extended hearth of the furnace and the small area of the regenerative system on the horizontal plane bringing all four of the regenerators entirely beneath the hearth of the furnace, the air from the regenerators d^2 and d^3 is obliged to pass over the top of the regenerators for gas, d^1 and d^4, while, in the example of the puddling furnace,

figures 11 and 12, in which, as I have already stated, the location of the regenerator chambers is not one continuous direct line, yet these chambers are so placed in regard to the puddling furnace above them that the distance travelled by the air and the gas on its way from each regenerator to the mixing chamber is practically the same.

X 38 Question. Will you be kind enough to state what you meant by saying in your direct testimony that the English patent has no specified claim?

Answer. I meant by this answer that there was no claim attached to the English patent specifying in detail the points claimed in the invention, but that one single claim is made to cover the various arrangements of regenerative furnaces, which I assume to be described or figured in the specification, and which are worked by gases resulting from an imperfect combustion of solid fuel in separate places, "as hereinbefore set forth," while in the American patent there are four distinct claims assumed to express what the inventors claim as their joint invention.

X 39 Question. Do you find any mention or allusion to the imperfect combustion of solid fuel in the claims of the United States patent referred?

Answer. There is no use of the word "resulting from the imperfect combustion of solid fuel in separate places" to be found in the claim attached to the American specification.

144 X 40 Question. Will you be kind enough to state why, in quoting the language of the claims of the United States patent referred to, you omitted the letters referring to specified parts of the apparatus illustrated in the drawings?

Answer. I did so to separate the claim from the specific examples given of what is described and figured as a puddling-furnace in the American patent, and to apply the claim in a broad sense to what I considered that claim applied in any of the many or various forms in which a furnace could be built coming clearly within the scope of the American patent, and which, if built, would be considered infringements thereon.

X 41 Question. You say, in answer to Question 5 of direct examination, after quoting from the English patent referred to: "I will also add it is essential in practice to regulate the proportion of incoming gas and air in order to obtain an oxidizing or non-oxidizing flame, if desired." Will you please state why this is essential?

Answer. If in metallurgic processes, in which a chamber or furnace is to be heated for the purpose of acting upon an oxidizable metal, such as iron, if the amount of air admitted to the furnace be greater than is needed to unite with and consume the gas from the fuel furnishing the gas, there will remain oxygen in the furnace which can unite with the heated metal, and so cause it to be burnt or consumed to the extent of the unappropriated oxygen in the excess of air so admitted, while, on the other hand, if the amount of air admitted be in any degree less than required to effect the combustion of the incoming gas, there is no oxygen left in the mixture of gases to attach itself to or to be appropriated by the oxidizable material within the furnace; so that by the use of properly arranged

dampers, and a judicious management of said dampers to regulate the inflow of gas and air into such a furnace, for instance, as is described in the Messrs. Siemens patent, either the English patent or the United States patent referred to, oxidizable material may be kept at a high heat for a very long time if the enveloping products of combustion of the heated gas and air be of such a mixture as to present no oxygen in its composition capable of attaching itself to the iron, while, on the other hand, if it is desirable that the material being acted upon by the mixed gases should have any portion of its constituents submitted to a consuming process—that is to say, while heated
145 be made to come in contact with oxygen in such a state or condition as to be capable of uniting with the same, and not already bound in other inseparable bonds—the admission of a larger proportion of heated air than is needed for the combustion of the gas only, may be made to present the proper conditions of available oxygen for this purpose. In the latter case the flame is called an oxidizing flame, while in the previous case cited it is termed a non-oxidizing flame, equivalent to the similarly named points in the ordinary blow-pipe flame, where the tip of the portion of the combined air and gas, where the air is already in excess of the burning gas, into which it has been forced, is called the oxidizing point of the flame, while that portion of the flame where the mixture of the air and gas is complete, or where the gas may be in excess of the air, is called the non-oxidizing portion of that flame.

X 42 Question. Is there not this difference between the puddling furnace illustrated in the English patent and the puddling furnace illustrated and described in the United States patent; that in the English patent the currents of gas and air oppose each other upon entering the mixing chamber and meet coming in opposite directions, whereas in the United States patent this is not the case?

Answer. In the two examples cited in illustration of the invention, the difference specified in the question exists so far as the direction of the incoming currents are concerned, in the English patent the two patents being directed toward the center of the mixing chamber, and thence proceeding laterally into the furnace, whilst in the example cited in the American patent the two ascending currents arise side by side and do not impinge one upon the other.

Re-ex. 43 Question. Do you find in the English patent 167 any statement as to how the outer air or atmosphere reaches the space I, in figure 3 of sheet 1 of the drawing?

Answer. I find the following sentence: "These regenerators are arched over at the top, and support the bed *a* of the furnace. This consists of a number of slabs of fire-clay, or other refractory material, having on their under side small channels, *e*, *e*, *e*, communicating at one end, through the chimney *f*, with the atmosphere, and at the other end with the air-passage I, conducting to the regenerators. A current of cold air is continually passing through these channels, tending to maintain the bed of
146 the furnace and the arches covering the regenerators at a low temperature." The passage-ways *e*, above alluded to, are semi-circular in form, twenty-two in number; taking their base as

the diameter and aggregating the areas, or combining the areas, we have eleven complete circles as units of area. These, if measured by the scale of one-sixteenth of an inch to the inch, are of such size as to represent at this scale eleven square sixteenths, equal to, say, eleven square inches; the passage-way *f*, from which they receive the cold air, measures three and a half sixteenths one way by four-sixteenths the other, making an area on the same basis of scale, namely, one-sixteenth of an inch to the inch, of fourteen square inches, apparently sufficient to feed with air the eleven square inches of the passage-ways *e;* the passage-ways *e* terminate in the chamber I, and from chamber I air passes to the regenerator through the damper chest *h;* the sectional area of this damper chest, which is a rectangular tube, and measures eight-sixteenths by thirteen-sixteenths, equals one hundred and four square inches. The only provision in the patent that I can find for access of air to chamber I is the above allusion, that the air passes from *f* through *e*, and which, by the measurements above given, accounts for eleven parts out of the one hundred and four capable of passing through the damper chest *h* at the same velocity of movement. Inasmuch in the English patent, on page 8, line 38, it is stated, "atmospheric air will enter the passage I into the regenerator B^3," and the passage I itself is very large as compared with the areas of passage *e*, measuring over two hundred square sixteenths of an inch, equal two hundred square inches on the same scale, I cannot but infer that some other opening, not shown in the drawing, for the admission of air into I would be necessary in successful working of the furnace as shown.

Re-X 44 Question. Do you not find in said English patent a reference to the chimney shaft in the glass furnace represented in figures 8 and 9?

Answer. I find on page 11, line 15, it is provided at one end "with a chimney shaft, D, having a damper, C."

Re-X 45 Question. Do you find any further reference to a chimney in the specification and communication between the chimney and furnace?

Answer. I find, in the continuation of the same subject, "beneath the bed *f* of the furnace, which is provided with chan-
147 nels, *e e*, for the circulation of cold air, are the four regenerators E^1, E^2, E^3, and E^4, constructed in a similar manner with those described with reference to figures 1, 2, 3, and 4." These communicate with a furnace, F and F^1, through the passages G^1, G^2, G^3, and G^4, and are connected below with the passages from the gas generators, the atmosphere, and the chimney, which are not shown in the drawing.

Re-ex. 46 Question. Do you find in the American patent 3265 any statement that the air passes upward from the cooling chamber C through chimneys, top of which is shown in plan in figure 1, and by dotted lines in figures 2 and 3?

Answer. I do not find any such statement.

Re-ex. 47 Question. Do you find in the English patent 167 anything that would prevent the air from passing upward from the

cooling chamber, corresponding with the chamber C in the American patent, through the chimney?

Answer. There is nothing shown to prevent it, and nothing showing that it does.

Re-ex. 48 Question. Is there anything in the American patent 3265 stating that there is a cooling chamber beneath the bed of the furnace, all the parts of which communicate with each other in such a manner as to allow the air to pass freely about and around the furnace bed?

Answer. There is an allusion to such a cooling chamber in the American patent, in the following words: "There is an air chamber or space, C, which should communicate freely at its opposite sides or end with the atmosphere in order that a current of cool air may be caused to continually pass through it, for the purpose of maintaining the bed of the furnace, as well as the arch of the regenerators B^2 and B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators while they may be in operation."

Re-ex. 49 Question. Do you find in the American patent 3265 anything prescribing the particular arrangement of the gas-regenerative chambers between the air-regenerative chambers, or indicating that this particular arrangement is essential?

Answer. I do not find anything prescribing the arrangement of the gas-regenerative chambers as being essentially necessary that they should be placed between the air-regenerative chambers,
148 and I only know that they are so placed in reference to one another by following the particular examples cited to illustrate the invention in the American patent, and learning the function of each particular part of the arrangement from the specification and letters of reference concerning the same. While at the same time I am led to infer, from a careful examination of the specification in question, that the inventors do not limit their claim to the specified position of the regenerative chambers in regard one to the other.

Re-ex. 50 Question. Do you find anything in the specification of reissue 3265 prescribing or describing as essential the arrangement shown of the mixing chamber above the point where the air and gas enter for combustion?

Answer. I do not find anything prescribing the special arrangement, nor do I find any allusions to a mixing chamber other than in the allusion that the gas and air pass out of the regenerators through passage *e*, leaping out of them into one common passage, *f* or f^1, which common passage, *f* or f^1 is situated at the top of the vertical passages, as it also is at the top of the vertical passages shown in English patent, figures 11 and 12.

Re-ex. 51 Question. You have said in answer to cross-question 18 that you do not find in the reissue 3265 the channel through which any overflow of cinder or metal may flow. Do you find in the American patent any explanation of the omission of this overflow channel? If so, give it.

Answer. I do not find in the wording of the specification any ex-

planation of the omission, but a careful examination of the drawing used to illustrate the American patent enables me to clearly point out the reason of the omission. In the specification of the American patent, figures 1, 2, 3, 4, and 5 are said to represent various views of a "puddling furnace," "with the said invention applied to it," while the drawings to which they refer do not represent a puddling furnace. The process of puddling iron requires that the furnace should be provided with a bed surrounded by walls of more or less height, which walls retain within the bed of the furnace the molten metal subjected to the puddling process. After the molten metal has been exposed a sufficient length of time to the requisite amount of heat, and has been stirred or worked by rabble bars through a small hole in the front door of the furnace, the metal, in technical parlance, "comes to nature;" the particles of wrought iron in a bath of cinder, which represents the state of the
149 material at this stage of the process are then aggregated into what are termed balls, and these balls, when ready for treatment in the squeezer or under the hammer, have to be lifted out over the front wall of the hearth of the furnace. By reference to figure 3 of the drawings of the American patent it is plainly shown, or it will be plainly seen, that the bed or hearth of the furnace is exactly on a level with the bottom of the door opening C. That a furnace so constructed could not contain melted metal, inasmuch as such metal if melted would flow out of the front door is very evident. It is also evident that the furnace shown is what is known in the trade as a heating furnace and not a puddling furnace, is such a furnace as would be used in a forge for heating the wrought iron bars or faggots to be hammered into shape, or to heat the piles of iron preparatory to the passage of these piles into the rolling mill, that being not intended for the treatment of molten metal, nor for containing molten metal provisions; for the overflow of such molten metal or cinder has not been shown. In my allusion to this furnace in all the testimony which I have given calling it a puddling furnace, I wish it clearly understood that I have adopted the name given to it by the men who claim to have invented it, considering that the kind of furnace that is placed above the regenerator and used for metallurgic or other processes is not limited by anything claimed in the claim of the patent referred to.

Re-ex. 52 Question. Does the American patent 3265 state or indicate that it is at all material in the construction or operation of the furnace illustrated in the drawing annexed thereto, or in the practice of the invention of which that illustration is an instance that the gas should rise into the mixing chamber in front of the air and between the air flue and the point where metallurgical and other operations are conducted in the furnace?

Answer. There is nothing to show that it is at all material.

Re-ex. 53 Question. Does the reissue 3265 prescribe or suggest as essential or material that the air regenerators should not be arranged immediately below the bed of the furnace?

Answer. I can find nothing to indicate that they should not be so placed.

Re-ex. 54 Question. Does the reissue 3265 assign any importance to the shape of the reversing valve?

Answer. None whatever; on the contrary, the shape of the
150 reversing valve is only inferred from the drawings attached to the specifications and forming parts thereof, where the butterfly valves U and S are shown with round ends to the wings. I can find no other indication to show that the tubular damper-case is cylindrical.

Re-ex. 55 Question. In view of the third claim of the reissue 3265, and referring back to the specification, do you find that the space E in the American patent and the space D in the American patent are both essential, or that the space D alone is deemed so?

Answer. I find in the description of the invention that in the rear of the upper part of the regenerators and below the furnace there is an air-space or chamber, D, which at intervals is bridged at *g*, *g*, *g*. There is also in the same description, below the space D, a similar space or chamber, E, in which are situated the levers for working the apparatus. I think that both of these parts are necessary in the construction of the furnace as shown. The bottom of chamber D is shown, in figure 3, as level with the under side of the top flange of the damper-chest, and this bottom is the crown of the arch of the passages *f*, *f*, shown in figure 6, which passages convey the atmospheric air from valve Y alternately into the two outer regenerators. In the arrangement as so figured there needs to be some chamber extending below the bottom of chamber D to give access to the axis of the reversing-valve S. The extent of this chamber, D, extends from out to out of the whole set of regenerators, while the length of the chamber E is not defined, but I think that lines in figure 1, in the plan bounding the outsides of the rectangles, marked D, D, are wrongly placed, and may have been meant to define the length of chamber E, inasmuch as I can find on no other of the drawings anything to indicate the use of these lines.

Adjourned to Tuesday, April 11, 1882, at eleven a. m.

151 Re-examination of Mr. SELLERS resumed Tuesday, April 11th, 1882, at 11 o'clock a. m.

Counsel present as before.

Re-ex. 56 Question. You have said, in answer to cross-question 22, "That in the United States patent the partition-walls between the air and gas regenerators extend vertically upward and form the division walls between the air and gas flues, and that such construction is not possible in the example cited in the English patent." Please explain why this construction is not possible in the English patent, and how far, if at all, this difference would affect the operation of a puddling furnace such as shown in the English patent.

Answer. There is but one example in the English patent of a puddling furnace; in this example an essential to a puddling furnace of some means of conveying away any molten material that may flow over or be splashed over that portion of the furnace where the

gas and air enter, or where the products of combustion pass out, is shown in a channel, N and O, situated between the flues J and K or L and M, the bottom of this channel being below the bottom of the mixing chamber, the true bottom of the mixing chamber being defined by the top or the walls which separate flues J, K, L, and M from channels N and O. In the United States patent the furnace figured, though called a puddling furnace, cannot be used to contain melted material, but is just such a furnace as is designed to heat iron to a welding point, either for forge or rolling-mill purposes, and if such furnace was altered into a furnace to contain molten metal by the building up of any wall across its front side, it would be in no safe condition for use as a puddling furnace, inasmuch as fluid metal escaping over the end walls would pass directly into the gas-regenerator chambers, to their injury or destruction. Now while the English patent contains a representation of what is at once recognized as a puddling furnace, the channels N and O, essen-
152 tials to such a puddling furnace, occupy the space taken by the direct gas and air passages shown in the United States patent, and while the construction shown in the United States patent is an eminently proper one when applied to a furnace used for heating only, I know of no way in which such construction could be made applicable to a puddling furnace with safety.

Re-ex. 57 Question. What difference, if any, does it make in the operation of the regenerative systems shown in the American and English patents respectively, that the partition wall between the regenerative chambers and the partition wall separating the air and gas flues are in the same vertical plane in the United States patent, and not in the same vertical plane in the illustrations given in the English patent?

Answer. I cannot see that it makes the slightest difference whether they are on the same plane or not. In the example cited of the furnace shown in the American patent such arrangement is eminently proper. The example given is but one of the many uses to which Mr. Siemens's regenerative system of furnace is applicable. The so placing of the verticle walls as shown in this illustration is, I have before stated, very good engineering construction; but adherence to this arrangement is in no way essential for carrying out the invention in its full scope if the furnace-bed should be of larger extent than the area covered by the regenerative system, as would be the case, I may say, in reference to glass furnaces. The extension of the bed over the whole of the area covered by the regenerative system, and in said case the impossibility of using the construction shown in the United States patent drawing; but the probable necessity of curved flues would still come entirely within the scope of the claims of the United States patent, which do not limit the patent to the particular arrangement of gas or air passages into or to such furnace.

Re-ex. 58 Question. What, if any, function does the space E in the American patent perform in conjunction with the space D, or what, if any, effect does the space E have by reason of its communicating with the space D?

Answer. The space E is of use in giving access to the axes of the dampers U and S. It is for this purpose and no other that it is dwelt upon as being essential; it is in fact the chamber in which the levers which operate the dampers U and S are placed. The
153 connection of this space with space D, so far as D serves as a passage-way through which air can pass on its way to damper-chest R, is entirely immaterial, nor can I find any intimation in the United States patent of the connection being essential, mention merely being made of a sunken space or chamber E as part of space D, in which are situated the levers for working the apparatus. Any building up of a partition wall to the level of the floor, thus entirely separating space E from the passage-way through which air passes to the damper-chest R, would not present an arrangement uncovered by the claims of the United States patent.

Re-ex. 59 Question. You have been asked if you find any mention or allusion to the imperfect combustion of solid fuel in the claims of the United States patent 3265. Disregarding the claims of the respective patents, please state how far the specification of the reissue 3265 corresponds with the specification of the English patent 167 in its description of the fuel to be used in the regenerative apparatus and in the derivation of such fuel.

Answer. In my answer to the original question to which this question refers (X 36) I said "there is no use of the words 'resulting from the imperfect combustion of solid fuel in separate places.'" What I mean by this is that these specific words are not used in the claim, nor do I find the same words made use of in the body of the United States specification; but I do find very clearly set forth, in both the English patent and the United States patent, a means of producing the gases required to successfully operate the Messrs. Siemens' process of regeneration as applied to any kind of furnace. The apparatus used to produce the gas required is called in the American patent a "gas generator;" it is also so called in the English patent. It is what is known in the trade at the present time as a "producer." In the American patent one view of this gas generator is shown in figure 8, corresponding so exactly with figure 5, sheet I, of the English patent that by placing the cloth tracing attached to the certified copy of the American patent (now before me) upon said figure 5 of the English patent all essential lines coincide, while the description of the device mentioned, as well as its mode of operation, seems to have been copied bodily, and almost word for word, from English patent No. 167; at least the descriptions contained in the two patents do so coincide. The chemical
154 changes which take place in this gas generator are such as result in the production of a gas originating in the imperfect combustion of the fuel in the gas generator, which gas generator is situated at some point more or less removed from the furnace in which the final combustion of the gas is to take place. I thus find that both patents agree in the most minute particular as to their method of making or preparing the gas which is in the furnace, intended to take the place of the solid fuel ordinarily employed in furnaces of older construction.

Re-ex. 60 Question. You have been asked in cross-examination as to various differences between the reissue 3265 and the English patent 167; do you find any of these differences particularized in the specification of the reissue 3265, or designated as material or as essential to the construction or operation of the improvements specified in the claims of the reissue 3265?

Answer. I do not. The description of a furnace illustrating the invention, appended to or making part of the United States patent, is the description in detail of a furnace figured in various views, and is only such a description as will enable one skilled in the art to understand the various parts and functions of the parts combined in the one illustration; but I find no word to indicate any reason why the general arrangement should not be varied to an unlimited extent so long as with the combination of furnace there is arranged a series of regenerators or means of receiving its waste smoke and gaseous products, or intercepting or receiving heat therefrom, and also some means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas during its passage into or to such furnace, for the purpose of improving or promoting combustion therein, by which it is necessary that, in connection with a chimney or smoke-discharge flue, there shall be a series of air and gas regenerators having conduits and dampers arranged so that gas may be led through such gas-regenerators and furnace and out of the chimney, and that certain air-space be provided between the bottom part of the furnace and the upper part of the regenerative system, wherein there shall be a free circulation of cool air, and there shall be some air-chamber to admit air to the damper-chest, and some means of working the damper or damper-chest, and that all these parts be constructed substantially as described; but I do not find why one or another arrangement of the various parts or devices necessary for the complete carrying out of the principles of the invention which might suggest themselves to the user of the invention, in reference to any specific furnace, or to the particular furnace figured, would be better or worse.

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Re-X 61 Question. Before testifying in this cause this day did you examine British letters patent of Frederick Siemens, dated December 2, 1856, No. 2861, and British letters patent to Charles William Siemens, dated May 11, 1857, No. 1320, for improvement in furnaces and the application of heated currents?

Answer. What do you mean by the term "this day?"

(Mr. WHITMAN replies: "I mean, have you at any time prior to this moment examined the patents referred to in the last question?)

WITNESS replies: I have seen blue-book copies of a patent issued to Frederick Siemens, bearing date the year 1856, and one to Charles William Siemens, dated 1857, but I do not remember the numbers of the respective patents as specified in the question. I have not seen them during this examination.

Re-X 62 Question. Is it not necessary to make provision in heat-

ing furnaces, as well as puddling furnaces, for withdrawing cinders and other impurities?

Answer. It is not necessary in a heating furnace to provide any device or arrangement for withdrawing cinders or other impurities beyond what is naturally furnished by the front door of said furnace, it affording the common means of levelling up the bottom or hearth and preparing it for the metal to be heated therein.

Re-X 63 Question. Have you examined the patent issued to Charles William and Frederick Siemens for gas producer, not involved in this suit?

Answer. I do not remember to have examined any patent of the kind referred to, though I may have done so at some period of my life.

Re-X 64 Question. Has your attention ever been called to a United States patent, not involved in this suit, issued to Charles William and Frederick Siemens, the subject-matter of which is a gas producer in all respects similar to the gas producer illustrated in figure 5, sheet 1, of English patent 167 of 1861?

156 Answer. My attention has not been especially called to any such patent; I may have seen such a patent.

COLEMAN SELLERS.

Affirmed and subscribed to before me this eleventh day of April, 1882.

CHARLES F. ZIEGLER,
Special Examiner.

THEODORE BERGNER, a witness on behalf of respondents, being duly sworn according to law, deposes and says, in response to the interrogatories proposed to him by Mr. Baldwin, counsel for respondents:

1 Question. What is your name, age, residence, and occupation?

Answer. Theodore Bergner; forty-eight years of age; Philadelphia; mechanical engineer.

2 Question. To what extent and during what period of time have you been familiar with drawings and specifications of patents for improvements in the arts, and what are your qualifications, from experience, for understanding such specifications and drawings?

Answer. I have been familiar with patent drawings and specifications ever since the year 1855. Since that time I have prepared many specifications and drawings for applications for patents, not only for my own inventions, but for the inventions of others, in whose behalf I have often made applications for patents. During a term of nearly eighteen years, from 1857 to 1874, inclusive, I have been employed by Messrs. William Sellers and Company as draughtsman, having during the greater part of this time had charge of their drawing department, and in this capacity having prepared many drawings and specifications for the numerous inventions and improvements originated by that firm in machine tools and other machinery and apparatus, in the construction of which and designing of detail I have aided during those years. I have procured several

patents for my own inventions during those years, and since then, and am familiar with drawings and descriptions of inventions in general.

3 Question. Have you examined a certified copy of the
157 reissued letters patent No. 3265, granted Charles William and Frederick Siemens under date of January 12, 1869, and do you understand the specification and drawings of that patent?

Answer. I have read and examined the certified copy of this patent, and understand its drawings and specifications.

4. Question. Have you read and examined the blue-book copy Defendants' Exhibit Complainants' English Patent of 1861, and do you understand the contents of that patent?

Answer. I have read and examined this blue-book copy, and understand the contents of its drawings and specification.

5 Question. Please compare the specification or description and claims of the reissue No. 3265 with the specification and drawing of the English letters patent last mentioned, and state how far you find what is described and claimed in said reissue No. 3265 described or shown or comprised in said English patent of 1861, giving your reasons for such an opinion as you may express.

(Objected to as immaterial.)

Answer. I have examined and compared what is described and claimed in the reissue 3255 with what is described or contained in the English patent No. 167, and I find the contents of the American reissue 3265 to be fully contained in the English patent, the greater portion of the literal description in the reissue being not only in substance but verbally the same in the English patent. While the English patent contains drawings and descriptions of several arrangements and applications of furnaces heated by the gaseous fuel, which descriptions and drawings are not to be found in the American patent, which is confined to the description in combination with the regenerative system of a furnace used for metallurgical purposes, everything essential contained in the reissue as descriptive of the regenerators, and of the furnace shown and described in connection therewith, is substantially and to a great extent literally contained in the English patent. What is claimed in the reissue No. 3265 is, with one exception, to be found in the description or specification of the English patent. The clause I refer to as not being contained in the description of the English patent is that part of the fourth claim of the reissue speaking of the combination of one regenerator with a furnace; neither does the specification of the reissue, except in this fourth claim, show or describe any possibility of making one regera-
158 tor available for the functions of the invention as described, its application being clearly described as limited to the use of either one or two pairs of regenerators.

Cross-examined by Mr. WHITMAN:

X 6 Question. Do you find anything claimed in the English patent No. 167 referred to, which is also claimed in the United States reissue concerning which you have testified?

(Objected to as incompetent; the witness not being a proper authority for construing the claim of the English patent, the construction of such claim being matter for the English courts and not for the witness.)

Answer. In the English patent the claim is wider and more extended in its scope than the claims in the American reissue. As I understand it, however, the various arrangements of regenerative furnaces worked by the gases resulting from an imperfect combustion of solid fuel in separate places comprise fully and entirely what is contained in the three first claims of the reissue 3265, and, with the exception referred to in my former answer as to the use of one regenerator, it may be said to embrace also what is comprised in this fourth claim of the reissue.

X 7 Question. Do you find any mention in the claims of the United States reissue of furnaces worked by the gases resulting from an imperfect combustion of solid fuel in separate places?

Answer. I do not find the use of these terms in the claims of the reissue. While it is clear to me, and must be to any one conversant with the arrangement and operation of these furnaces, that the gases used therein are the result of an imperfect combustion of solid fuel, and while the combination with a furnace and its chimney or smoke-discharge flue of any system or series of air and gas regenerators comprises in their operation the use of such fuel resultant from an imperfect combustion of solid fuel, I can only view the claim in the reissue 3265, not mentioning in the words of the English claim the working by gases resultant from an imperfect combustion of solid fuel as being narrower than the English claim.

X 8 Question. Are you aware that Charles William and Frederick Siemens have taken out another patent in the United States, and which is not mentioned in the bill of complaint in this
159 suit, for a gas producer similar in its construction and operation to the gas producer illustrated by figure 5, sheet 1, of the English patent referred to and described in the English patent referred to?

Answer. I have seen a copy of such American patent, and believe it to contain a drawing of a gas producer very similar in construction and operation to the one mentioned in the question as shown in figure 5 of sheet 1 of the English patent 167. I do not recall the date or any detail of the contents of said American patent further than its drawing.

X 9 Question. According to the construction of figure 3 of the English patent 167, does the air which flows through the air regenerator flow also through the passages marked *f* and *e*?

Answer. These passages, *f* and *e*, are shown in this view as communicating with the air passage I in such manner that the air flowing through *e* and *f* may be conducted through the regenerator.

X 10 Question. Is there not, then, this difference between United States patent reissue No. 3265 and the English patent No. 167; that is to say, that in the English patent the air for cooling the bed of the furnace is drawn downward through the passages *f* and *e* into the

chamber I, and from thence to the air regenerator; whereas in the United States patent referred to the air will rise from cooling chamber C, according to well-known physcical laws?

Answer. The difference referred to in the above question, while immaterial and not specially referred to in the specification as to the purpose of downward drawing of the air, cooling the bed of the furnace and the crown or arches of the top of the regenerators, does exist when comparing figure 3 of the English patent with the drawings of the reissue; but in figure 11, sheet 2, of the English patent we have an arrangement of such air passages identical in their arrangement with those shown in the reissue and in both specifications they are described, as to their object, in identical terms.

X 11 Question. Please state whether there is anything in figure 11 of the English patent or in the description of figure 11 in the English patent to indicate what direction the air takes after leaving the chamber marked *a*.

Answer. There is no indication in figure 11 or in the de-
160 scription referring thereto as to the direction the air takes after its circulation through the spaces *a a*, for the described purpose.

X 12 Question. Is there anything in figure 11 of the English patent or in the specification of the English patent to indicate that the heated air in the chamber *a* is not drawn downward, as in figure 3 of the English patent, concerning which you have just testified?

Answer. There is nothing to indicate that the air, heated by its passage through the spaces *a*, is not to be drawn downward in figure 11 of the drawing, in the manner indicated in figure 3.

X 13 Question. Is there not this difference between the English patent No. 167 and the United States reissue 3265, that in the latter patent there is a cooling chamber beneath the bed of the furnace, all the parts of which communicate with each other in such a manner as to allow the air to pass freely about and around the under side of the furnace bed, whereas in the former—that is, the English patent—three or more separate chambers or passages are shown below the bed of the furnace, such chambers not communicating with each other?

Answer. There is nothing to show, in the English patent, whether the spaces *a* in its figure 11 are each in themselves separate, or whether they communicate with each other by transverse passages, such as are shown in figures 2 and 3 of the United States reissue, there being no sectional view at right angles to figure 11 in the English patent, as is the case is the United States reissue, where figure 2 represents a section on or about the same plane through the furnace as in figure 11 of the English patent. The additional sectional view, figure 3 of the reissue, has not been included in the drawings of the English patent; the space *a* in the English patent and the air chamber or space C in the reissue are identical in their functions, both being described as a space for the circulation of cold air between the arches covering the regenerator and the under side of the bed of the furnace, for the purpose of maintaining the bed of

the furnace and the arches covering the regenerators at a low temperature. It must be immaterial whether all passages unite with each other as long as the object described is attained.

Adjourned to Wednesday, April 12, 1882, at eleven o'clock a. m.

161 Examination of THEODORE BERGNER resumed, April 12, 1882, at 11 o'clock a. m.

Counsel present as before.

X 14 Question. Is there not this difference between the puddling furnace illustrated in English patent 167 and the furnace illustrated in the United States reissue patent No. 3265, that in the English patent the currents of gas and air oppose each other upon entering the mixing chamber, and meet coming in opposite directions, whereas in the United States patent this is not the case?

Answer. In the puddling furnace referred to in the question, and shown in the figures 11 and 12, sheet 2, of the English patent 167, the incoming currents of air and gas rise side by side, and mingle as they approach the mouth of the furnace from opposite directions, while in the furnace shown in the reissue No. 3265 the incoming gases and air also rise in a vertical direction and mingle as they turn towards the mouth of the furnace, the air passing over the intervening wall between the two vertical flues for air and gas, and striking the upward current of gas immediately before their combined entrance into the furnace. There is not the opposing direction of the two currents in this arrangement of flues as indicated in figure 12 of the English patent.

X 15 Question. Please state whether you have had any experience in the practical working of furnaces constructed according to the regenerative system of Siemens.

Answer. I have not been engaged in any iron works or other establishment where such furnaces, operated upon the regenerative plan, were in operation, but I have made numerous working drawings and other sketches and designs of various modifications of such furnaces, and understand their construction and principles of operation. I have made such drawings while employed by Messrs. William Sellers and Company.

X 16 Question. Is Mr. William Sellers, one of the defendants in this suit, a member of the firm of Sellers & Company mentioned in your last answer?

Answer. He is the senior member of that firm.

162 X 17 Question. Were the drawings to which you allude made from other drawings which were furnished to you?

Answer. My manner of making drawings or designs was not in the capacity of a copyist, and in almost every case the subject to which any drawings to be made referred was discussed by Mr. William Sellers and myself, and frequently illustrated by drawings received from elsewhere and by sketches made by either one of us at the time for suggesting certain modifications of plans in general or of minute details involved. The same manner of proceeding was

followed in those cases with which drawings of regenerative furnaces were connected.

X 18 Question. Have you had any practical experience in the working of a Siemens furnace other than that of a draughtsman?

Answer. Although I have not worked at or with any Siemens furnaces, I think my experience is more than that of a draughtsman. While at the Vienna Exposition in 1873 as representative of the firm of William Seilers & Company, I had among other machines and apparatus a rotating puddling furnace on exhibition, which was viewed by many of the leading iron men of Europe, with one or several of whom I was in daily verbal or other communication on the subject. I made the personal acquaintance of Mr. Max Hermann, the representative of the Dresden house of Siemens. This acquaintance became very intimate. I visited subsequently the works of Messrs. Siemens at Dresden, together with Mr. Hermann, and there saw regenerative furnaces in practical operation for the manufacture of glass.

X 19 Question. In your examination of the English patent referred to have you discovered that a disclaimer had been filed as regards certain portions of the English patent?

Answer. I have not made any such discovery, and have not noticed the existence of any disclaimer.

X 20 Question. Please examine English patent 167 and state for what purpose the damper marked *w* in figure 3 is used.

Answer. There are two such dampers, *w*, at the top of pipes T, conducting the gas from two producers, placed side by side, into a common conduit or gas flue, U, and these dampers, *w*, serve to connect their respective producers with the system in operation or to disconnect any of the producers for the purpose of repairs or
163 otherwise, and they may also serve to regulate the quantitative escape or supply of gas from any one of the producers according to the condition of the gas production going on therein.

X 21 Question. Do you find any other means shown in the drawings of the English patent 167 than the valve *w* for regulating the amount of gas which flows from the gas producer to the gas regenerative chamber?

Answer. I find the damper G, in the same view, referred to for regulating the direction of the current of ingoing gas, and for alternating the direction of this current, but not for regulating its quantitative supply.

X 22 Question. Does not the American patent No. 3265 differ from English patent No. 167 in this; that in the American patent is shown a gas-regulating valve, X, with means for operating the same, which may be worked independently of the air-regulating valve Y; that is to say, when the air is allowed to flow into the furnace by one valve the gas may be wholly or partially shut off by the other, whereas, in the English patent referred to, no valve for regulating the inflow of gas is shown as being worked by the valve governing the inflow of air?

Answer. While there are no valves shown in the drawings of the English patent identical with the valves X and Y, shown in figure

3 of the reissue, the necessity of separate quantitative admission of air and gas is accounted for in the English patent, in which I find the following clause: "Dampers are provided in the cold air and gas channels, by which the quantity and quality of the flame can be regulated to the utmost nicety."

X 23 Question. Does the quotation referred to in your last answer occur in the provisional specification of the English patent, or in the specification pursuant to the conditions of the letters patent filed by Charles William and Frederick Siemens in the Great Seal Patent Office, on the 22d of July, 1861?

Answer. I have quoted the above from the provisional specification, but in the complete specification, filed July 22, 1861, I find the following: "The currents of heated gas and air, in ascending through and from the regenerators into the furnace, causing a plenum of pressure within the same which is capable of being modified or regulated by valves for the admission of the gas and air to
164 the regenerators and by the chimney-damper. By the same arrangements the chemical qualities, as well as the intensity of the flame, can be regulated to the utmost nicety."

X 24 Question. Does not this difference also exist between the United States and English patents referred to; that is to say, that in the United States patent there are tubular damper cases having oval dampers contained within them, whereas in the English patent the damper cases are not cylindrical and tubular, nor are the dampers of oval form?

Answer. I do find this difference between the two patents, as regards the form of section of the respective tubes or channels and the dampers fitted within them, they being round in the United States reissue and of rectangular form with rounded corners in the English patent 167; that is to say, the dampers in the latter show their corners as being rounded, while the respective flues do not indicate any rounding of the corners. There are round flues and oval dampers shown in figures 15 and 16 of sheet 2 of the English patent.

X 25 Question. Please designate by letter the round flues and oval dampers shown in figures 15 and 16 of English patent.

Answer. I referred in my last answer to the round flues E^1, E^2, E^3, and E^4, and their oval dampers, shown, but not designated by letter, and being operated by the levers b^1 b^2 b^3 b^4, the round form of the flue and consequent oval form of the dampers being designated in figure 16, and as regards the damper also in figure 15, in which the dampers, when closed, occupy an angular position within their respective flues, and are consequently oval.

X 26 Question. Are you aware that a disclaimer has been filed by Charles William Siemens and Frederick Siemens, disclaiming the apparatus shown in figures 15 and 16 of the English patent 167, and the descriptive matter of said specification relating to said figures?

Answer. I am not aware of the filing of such disclaimer.

X 27 Question. Does not this difference exist between United States No. 3265 and English patent 167; that is to say, that in the

American patent there is the space E arranged immediately below and communicating with the space D, whereas in the English patent there is no communication between the space E and the space D immediately above it?

Answer. The only difference between the two apparent to me is that in the reissue patent there is nominally a space, D, above
165 the space E, said space D being below and between arched dividing walls G, shown in the drawing, the space D being in reality as open to the atmosphere as the space in the drawing, figure 11 of the English patent, immediately above that space in this view, which is the same as space E in the reissue. For all practical utility the two are in so far identical, as in the English patent the open space above that opening, through which air enters and the dampers are regulated, is not obstructed by the walls incidental to the arrangement shown in the reissue. In all essential respects both give free admission for the air and the required access to the regulating levers.

X 28 Question. Does not this difference also exist between the English patent No. 167 and the United States patent No. 3265; that is to say, that in the United States patent a direct communication exists between the air-chamber below the bed of the furnace and the outer atmosphere, as shown more particularly in figure 5 of the United States patent at the point marked C, whereas the only egress for the air in chamber below the furnace indicated in the English drawings and described in the English specification is that to the chamber I, shown best in figure 3 of sheet 1 of the English drawing?

Answer. I cannot agree that this difference does exist between the two patents, inasmuch that in figure 11 of English patent 167 spaces *a a* are described as being provided for the circulation of cold air, and the purpose of this circulation of cold air implies, in the absence of a sectional view at right angles to figure 11, that they are open for the free circulation of cold air; nothing in figure 11 or in the description appertaining thereto showing that the air from these spaces *a a* is anything but in free communication with the atmosphere.

X 20 Question. In United States patent reissue 3265 the following language is used in regard to the air chamber below the furnace: "There is an air chamber or space, C, which should communicate freely at its opposite ends with the atmosphere;" and in the English patent, complete specification, page 12, lines 28 and 29, the following language is used in describing spaces below the furnace: "Below the bed spaces *a a a* are provided for the circulation of cold air." Does it not follow from this language that in the English patent three or more spaces beneath the furnace are described, and that in the United States patent a single space below the furnace is described?

166 (Objected to as assuming that the quotation from page 12 of the English patent applies to the entire patent, whereas it appears only in connection with figures 11, 12, and 13.)

Answer. The space C referred to in the reissue patent 3265 is there called an air space or chamber, which should communicate freely at its opposite sides or ends with the atmosphere, while in the part of the English patent referred to in the question, it is stated that "below the bed spaces *a a* are provided for the circulation of cold air." Their number is not designated in the description, while four such spaces, which may or may not communicate with each other by transverse channels, are shown in figure 11 of the drawing. They are designated as spaces in the English specification, and as an air chamber or space in the reissue patent. In the provisional specification of the English patent I find the following: "We form a space for the circulation of cold air between the arches covering the regenerator and the under side of the bed of the furnace."

X 30 Question. What reason have you for saying, in your last answer, "four such spaces, which may or may not communicate with each other," when there is nothing in the descriptive language of the specification or the drawings of the English patent to indicate that the spaces *a* may communicate with each other?

Answer. Because in the reissue patent the drawings show that the supports of the bed of the furnace placed within the chamber C allow a lateral communication of the air between them, while the supports shown in figure 11 of the English patent 167 are not shown in any other view, and are not described as extending the entire length of the spaces *a a* under the bed of the furnace; and this was my reason, in the absence of such drawing, that there may or may not be lateral communications between them. It is, therefore, only an assumption on my part, in the absence of the view in the English patent, which view is shown in the reissue patent.

X 31 Question. Do you consider the extent of the area of the space below the combustion chamber of the furnace essential to the successful working of the furnace?

Answer. I think the extent of such area of cooling space under the bed of the furnace is essential, and should be, in a great measure, determined by the use of the furnace and the degree of temperature developed within the same.

167 X 32 Question. Does not this difference also exist between the English patent No. 167 and the United States reissue patent No. 3265, that the partition wall between the regenerative chambers and the partition wall separating the air and gas flues are in the same vertical plane in the United States patent, whereas no such construction is shown or described in the English patent?

Answer. This difference does exist in the respective drawings of the two patents referred to, and is, although not particularly described or referred to as serving any specified essential purpose in either case, incidental to the relative disposition of the four regenerative chambers beneath the furnace applied in combination therewith.

X 33 Question. Does not this difference exist between the United States patent No. 3265 and English patent No. 167; that is to say, that in the United States patent the gas rises into the mixing chamber in front of the air and between the air flue and the point where metallurgical and other operations are conducted in the furnace, whereas in the English patent no such construction is shown?

(Objected to as confusing the operation with the construction of the respective patents.)

Answer. The difference pointed out in the question does exist in so far as in figure 1 of sheet 1 of the English patent 157 the air from the inner regenerative chamber is conducted over the outer regenerative chamber, from which the current of gas issues, the two being then brought together and mixed in their passage to the furnace, while in figure 2 of the reissue patent 3265 the gas issues in an upward direction into the current of heated air passing over it and mingling with it for their combined admission into the furnace.

X 34 Question. Before testifying in this cause did you examine British letters patent to Frederick Siemens, dated Dec. 2, 1856, No. 2861, and British letters patent to Charles William Siemens, dated May 11, 1857, No. 1320, for improvement in furnaces, and in the application of heated currents?

Answer. Before testifying in this cause I saw several copies of English patents granted to the Messrs. Siemens other than the one 167 of 1861, but I do not now recall their dates or respective precise contents, or by whom of the two brothers Siemens the several inventions or improvements were claimed.

168 X 35 Question. In your answer to cross-question 33 you say that the gas enters in an upward direction into the current of heated air passing over it. What would cause the current of heated air to pass over the gas in the United States patent referred to?

Answer. Because there is but one outlet for the two upward currents in a horizontal direction, and the upward current farthest removed from the outlet into the furnace must pass over the vertical outlet from the inner or intervening regenerative chamber, and so cause a mingling of the two currents.

X 36 Question. Is there any construction shown in the English patent No. 167 whereby the air may be made to enter the furnace above the gas, in the manner you have just described in referring to the United States patent No. 3265, reissue?

Answer. I have not described the air as entering the furnace above the gas; in both cases the air and gas are so conducted to the furnace as to permit their admixture before they reach the point of combustion, and in the English patent, figure 1, the length of the conduit from the top of the two regenerators is greater in the reissue patent, figure 2, this being due to the respective dimensions of the two furnaces shown, with reference to the dimensions and disposition of the regenerative chambers beneath them; so that while in the reissue patent the mingling of air and gas takes place during a very short distance of movement, in figure 1 of English patent the distance traveled by the air and gas from the tops of their respective regenerators to the combustion chamber is greater, allowing, therefore, for their thorough admixture, although they do not so directly clash with each other as in the spaces *f* and *f'* in figure 2 of the reissue.

X 37 Question. If the air does not enter the furnace above the gas, be good enough to state what you meant by saying, in answer

to cross-question 33, "the gas issues in an upward direction into the current of heated air passing over it."

Answer. Before answering this question I would like to refer to the remainder of my answer from which you have just quoted.

(Counsel for Messrs. Siemens replies that witness may refer to the answer in any manner he chooses.)

Witness answers: It is intended in my answer referred to in the question, and I think will be so understood, that the cur-
169 rents of heated air and gas mingle before their combined entrance into the furnace, and not that the air can pass over the current of gas without the two mingling before they reach the point of combustion.

Re-examined by Mr. BALDWIN:

Re-X 38 Question. How far does the operation of the combination specified in the first claim of the reissue patent 3265 in manner and so as to be operative as and for the purposes therein before described include the operation of the furnace by the gases resulting from an imperfect combustion of solid fuel in separate places, as such operation is conducted or described to be conducted in the English patent 167?

Answer. The operation of the combination comprised in the first claim of the reissue 3265 comprises the use of gases resulting from an imperfect combustion of solid fuel in separate places, as claimed and described in the English patent No. 167.

Re-X 39 Question. How far does the reissue No. 3265 correspond with or differ from the English patent 167 in its description of the means and method for obtaining from the imperfect combustion of solid fuel in separate places the gas for operating the furnace?

Answer. In this respect the two are identical; the means and method for obtaining the gas from the imperfect combustion of solid fuel in separate places, and for applying the gas so obtained for the operation of furnaces, are the same in both descriptions.

Re-X 40 Question. How far is the combination specified in the fourth claim of the reissue 3265, disregarding the reference therein to one regenerator, included, in its construction and operation, in the description and drawing of the English patent 167?

Answer. This combination, and its construction and operation, is fully shown and described in the English patent No. 167.

Re-X 41 Question. How far do you find in the English patent 167 described and shown the arrangement and combination of the air-space or open chamber C and its system of regenerators, ar-
170 ranged and applied together substantially in manner and so as to operate as described in the reissue No. 3265?

Answer. I find in the English patent substantially the same arrangement and combination of the air space or open chamber C with the furnace and its system of regenerators, arranged and applied together, and so as to operate in the manner claimed in the reissue 3265.

Re-ex. 42 Question. How far do you find in the English patent

167 described and shown the combination of the air chamber or space D, or the same in the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified in the reissue No. 3265?

Answer. I find in the English patent No. 167 substantially the arrangement and combination of parts specified in this claim of the reissue.

Re-ex. 43 Question. Do you find any statement in the reissue 3265 that there is a cooling chamber beneath the bed of the furnace, all the parts of which do in fact or should necessarily communicate with each other for any purpose?

Answer. I do not find any such statement as to the necessity of having all the parts of the cooling chamber C necessarily communicating with each other for any purpose.

Re-ex. 44 Question. Do you find any statement in the English patent 167 that the three or more separate chambers shown below the bed of the furnace do not communicate with one another?

Answer. I do not find any statement in the English patent 167 that these spaces or chambers do not communicate with each other.

Re ex. 45 Question. Do you find anything in the reissue 3265 prescribing any particular direction to be given to the currents of air and gas so that they shall not oppose each other upon entering the chamber?

Answer. I do not find anything in the reissue 3265 that the currents of air and gas shall not oppose each other in their passage to the furnace where they are to be fired.

Re-ex. 46 Question. Do you find anything in reissue 3265 assigning any importance to the shape of the damper cases or dampers?

Answer. I do not find anything of this nature in the reissue.

171 Re-ex. 47 Question. Do you find anything in the reissue 3265 assigning any importance to there being any communication between the space D and the space C referred to in the third claim?

Answer. I do not find any such reference to the importance of such communication. I only find the following in relation thereto in specification: "There is also below the space D a sunken space or chamber, E, in which are situated the levers for working the dampers of the apparatus."

Re-ex. 48 Question. Do you find any intimation in the specification of the reissue 3265, or in the third claim thereof, that the space E is essential to the operation of the arrangement and combination specified in the third claim so long as the space D is provided substantially as specified?

Answer. I find that so long as the space E is provided in this combination the space D is not at all essential to the arrangement and combination of the parts embodied in this claim.

Re-ex. 49 Question. Do you find anything in the reissue 3265 prescribing that the partition walls between the regenerative chambers and the partition walls separating the air and gas flues shall be in the same vertical plane?

Answer. I find nothing prescribing this disposition of parts as

necessary or essential to the operation of the parts described and claimed.

Re-ex. 50 Question. Do you find anything in the reissue 3265 which refers to the drawings annexed to that reissue as being anything more than views of a puddling furnace to which the invention is applied, and the literal description of those views?

Answer. I find figures 1 to 5, inclusive, represent a puddling furnace to which the invention is applied, and figures 6 and 7 views referring more particularly to the regenerators. In the description the word "puddling furnace" is used, but oftener the word "furnace." The word "furnace," however, only occurs after the term puddling furnace, or furnace for puddling iron, has been used, and in all cases where reference has been made to the drawings the word "furnace" applies to the puddling furnace shown.

Re-ex. 51 Question. Do you find anything in the reissue 3265 confining the invention described and specified to the particular application of the improvement to a puddling furnace?

172 Answer. I do not find the invention described as so confined. The specification states that the invention may be carried out in its application to a furnace for puddling iron, or for any other purpose where the furnace is to be heated to a high degree. The specification also refers to the use of the furnace for firing pottery ware, calcining ores, and other operations; also to the melting of various superior qualities of glass in open pots, or for the melting of steel and other substances upon an open bed or hearth.

Re-ex. 52 Question. Which of these applications of the inventions thus mentioned in the reissue 3265 do you find mentioned in the English patent 167?

Answer. I find all these applications mentioned in the English patent.

Re-ex. 53 Question. In cross-examination you have been asked whether or not various differences specified in various questions did not exist between the reissue 3265 and the English patent 167, and you have answered in some cases that the specified difference did exist. State whether those differences which do exist between the two patents are between the specifications or merely between the drawings of the English patent 167 and the reissue 3265?

Answer. The differences referred to are in the parts, so far as they are shown in the drawings, and not relating to the respective specifications.

Recross-examined by Mr. WHITMAN:

Re-X 54 Question. Mr. Bergner, under our law, do you understand that the drawing attached to a patent forms a part of the specification of a patent?

(Objected to as incompetent, the witness not being a lawyer, and the question being one for the court, and it depending, when such question arises upon the manner in which the specification refers to the drawing, how far the drawings are parts of the thing patented.)

Answer. I understand that such is the case, but that in English patents, in the absence of any model, the drawings frequently indicate many views of parts illustrative of a variety of applications to which the invention may be susceptible, while I understand
173 it to be the case with American specifications that they are more restricted or confined in their limits of illustration by drawings.

Re-X 55 Question. Do you find in the United States patent 3265 any drawing or description which would enable a party skilled in the art to which the invention relates to construct a kiln of any kind?

(Objected to, as the construction of a kiln does not belong to the art to which this invention relates.)

Answer. I do not find anything in the reissue instructing those skilled in the art how to build a kiln.

Re-X 56 Question. Do you find anything in the specification and drawing of reissue letters patent 3265 which would enable a party skilled in the art to which the said patent relates to construct an apparatus for firing pottery ware?

Answer. The construction of an apparatus for firing pottery ware would be, as I understand it, within the scope of a person skilled in the art of manufacturing pottery, and not appertaining to the details of the furnace described in this patent. I do not find any such minute or detailed description of an apparatus for firing pottery ware as would enable any skilled mechanic to construct it thereby.

Re-X 57 Question. Do you find anything in the specification and drawings of reissue letters patent 3265 which would enable a party skilled in the art to which said patent relates to construct an apparatus for calcining ore?

Answer. I do not find any such description of an apparatus for calcining ore from which such apparatus might be constructed.

Re-X 58 Question. Are you aware that Charles William Siemens and Frederick Siemens, the patentees mentioned in reissue letters patent No. 3265, have taken out numerous patents in this country relating to the application of the regenerative system to glass furnaces?

(Objected to as incompetent, irrelevant, and not proper recross-examination.)

Answer. I do not know the nature and number of other United States patents taken out by Messrs. Charles W. and Frederick Siemens clearly enough to understand their range of application.

Re-X 59 Question. Is there anything in specification and
174 drawings of reissue letters patent 3265 which would enable a party skilled in the art to which said patent relates to construct a glass furnace?

Answer. There is no such instruction for the building of a glass furnace contained in the reissue.

Re-X 60 Question. Have you labored under the impression, while testifying in this case, that it is necessary for a patentee to advertise

the advantages of his invention in the specification of his patent, or have you been under the impression that it is only necessary for him to describe his invention in such a manner that a person skilled in the art to which the patent relates may construct and use it?

Answer. I have always understood, since I have been familiar with patents, more particularly American patents, that it is necessary for the inventor to describe the nature and objects of his invention so fully and clearly that others skilled in the art may be enabled to construct the invention or improvement claimed. I had not been under the impression that specifications are drawn for the purpose of advertising the advantages of the invention.

Re-examined by Mr. BALDWIN:

Re-ex. 61. Question. Do you find anything in the reissue 3265, taking the specification and the drawings together, that would enable any person skilled in the art to which the invention appertains to construct a puddling furnace or a furnace in which the operation of puddling iron could be conducted?

(Objected to as not proper re-examination.)

Answer. The description and the drawings of this reissue do not contain such detailed description of a puddling furnace as would be sufficient or apparently intended to be precise enough to enable any one skilled in the art to construct a puddling furnace in all its details.

THEODORE BERGNER.

Sworn and subscribed before me this twelfth day of April, A. D. 1882.

CHARLES F. ZIEGLER,
Notary Public, Special Examiner.

175 DEFENDANTS' EXHIBIT COMPLAINANTS' REISSUE LETTERS PATENT NO. 3265.

THE UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissued letters patent granted Charles William and Frederick Siemens 12th January, 1869, No. 3265.

In testimony whereof I, Samuel S. Fisher, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed, this twentieth day of July, in the year of our Lord one thousand eight hundred and sixty-nine, and of the Independence of the United States the ninety-fourth.

[SEAL.]

SAM'L. S. FISHER,
Commissioner.

Reissue No. 3265.

THE UNITED STATES PATENT OFFICE.

To all to whom these letters patent shall come:

Whereas, Charles William Siemens and Frederick Siemens, of Westminster, England, have alleged that they have invented a new and useful improved regenerator furnace for metallurgists and others (for which letters patent were issued to them dated March 1, 1864, which letters having been surrendered by them, the same have been cancelled and new letters ordered to issue to them on an amended specification), and have made oath, the said Charles William Siemens, that he is a subject of Great Britain, and the said Frederick Siemens that he is a subject of the Grand Duke of
176 Mecklenburg-Strelitz, in Germany; that they verily believe that they are the original and first inventors or discoverers of the said invention, and that the same hath not, to their knowledge and belief, been previously known or used; have paid into the Treasury of the United States the sum of thirty dollars, and presented a petition to Commissioner of Patents, praying that a patent may be issued therefor.

These are, therefore, to grant to the said Charles William and Frederick Siemens, their executors, administrators, or assigns, for the term of seventeen years from the first day of March, one thousand eight hundred and sixty-four, the full and exclusive right and liberty of making, using, and vending to others to be used the said invention, a description whereof is given in the annexed schedule and made a part of these presents.

In testimony whereof I have caused these letters to be made patent, and the seal of the Patent Office to be hereunto affixed.

Given under my hand, at the city of Washington, this twelfth day of January, in the year of our Lord one thousand eight hundred and sixty-nine, and of the Independence of the United States of America the ninety-third.

[SEAL.]

W. T. OTTO,
Acting Secretary of the Interior.

Countersigned and sealed with the seal of the Patent Office.

ELISHA FOOTE,
Commissioner of Patents.

177 UNITED STATES PATENT OFFICE.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS, of Westminster, England.

Letters patent No. 41788, dated March 1, 1864; reissue No. 3265, dated January 12, 1869.

Improved Regenerator Furnace for Metallurgists and Others.

The schedule referred to in these letters patent and making part of the same.

To all persons to whom these presents shall come:

Be it known that we, Charles William Siemens and Frederick

Siemens, residents of Great George street, Westminster, in or near the city of London, of the kingdom of Great Britain, have made a new and useful invention, having reference to furnaces of various kinds, and we do hereby declare the same to be fuliy described in the following specification, and represented in the accompanying drawings, of which—

Figure 1 is a top view, figure 2 a longitudinal section, figure 3 a transverse section, figure 4 a rear elevation, and figure 5 a front elevation of a puddling furnace with our said invention applied to it. Figure 6 is a longitudinal section taken through the air valves and passages of the two outermost or air regenerators, to be hereinafter described. Figure 7 is a transverse section taken through one of the outermost regenerators.

The object of our invention is not only to economize heat, or to save and utilize much of it that is generally wasted by being allowed to escape into and through the chimney of a furnace, but to produce heat by the combustion of gases and atmospheric air in mixture, the gases being derived from coal or other fuel by a furnace such as we shall hereinafter explain, or by any other suitable means or apparatus. In carrying out our invention in its application to a furnace for puddling iron, or for any other purpose where the furnace is to be heated to a high degree, we arrange four of what we term the "regenerators" below the level of the bed of the furnace, and when all or any of them may be placed immediately underneath the furnace we form underneath the latter a space for the circula-
178 tion of cold air, the top of the regenerator or regenerators which may be immediately underneath such space, being duly covered. Passages lead from the upper part of two of these regenerators into the furnace, or into a channel or passage communicating with one end thereof. Similar passages lead from the two remaining regenerators, and in a similar manner communicate with the opposite end of the furnace. The lower parts of the four regenerators have passages leading into them respectively. To one of the regenerators of each pair, at either end of the furnace, the passage leading into its lower part is to open into the atmosphere so as to supply the regenerator with atmospheric air. The passage leading into the lower part of the other regenerator of the pair is a gas conduit for supplying its regenerator with gas. The several passages communicate with a flue or chimney, and have valves and reversing dampers, by means of which currents of air and combustible gas or gases may be directed through the furnace, and the whole system of regenerators in the following manner: A current of air is to be caused to flow into the lower part, and up through one of the regenerators of one of the two pairs of them. At the same time a current of gas is to be made to flow into the lower part of the other regenerator of such pair. After ascending through their regenerators, or between the bricks of the mass of loosely piled brick-work or other refractory material making part of such regenerator, the said aerial and gaseous currents unite and flow into the furnace, where they are to be fired. The heated volatile products or spent gases resulting from the combustion of the said currents of air and gas will

flow out of the furnace and into and down through the two remaining regenerators, and after circulating through the masses of brick-work or refractory material of which such regenerators are composed in part, the said spent products will be directed into and will escape by the chimney. When the last two regenerators may have been sufficiently heated the direction of the aerial and gaseous currents is to be reversed—that is to say, the currents of air and gas are to be caused to enter the two last-mentioned regenerators separately—that is to say, air is to pass into one and gas into the other. In ascending through the regenerators the air and gas will be heated, or will absorb from the masses of brick-work much of the heat previously imparted to them, after which the two currents will
179 unite and flow into the furnace, and there will be inflamed, and will produce a flame of very great intensity or heat. The spent products of combustion will flow out of the furnace and thence down through the remaining two regenerators, and after imparting their heat to them, or having it more or less obstructed by them, will be directed into and caused to escape by the chimney. The supplying ærial and gaseous currents are thus to be thrown through the pairs of regenerators alternately, their combustible products escaping through the discharging pair and serving to heat them, while they in turn serve to heat the ærial and gaseous currents when caused to flow through them.

Before proceeding to more fully describe our invention we will explain a gas generator such as may be employed in connection therewith, the said generator being shown in vertical section in Fig. 8. One or more of these generators may be used in connection with a conduit or conduits for the conveyance of gas to the regenerators. In this gas generator O is a hopper or induct, into and through which the coal or fuel is to be introduced, the said hopper being closed by means of a cover, *a*, after it may have received a supply of fuel. From the hopper the fuel descends an incline plane P, composed of fire-brick or other proper refractory or heat-resisting material, it being inclined at an angle of about forty-five degrees to the horizon. From thence the fuel passes upon a fire-grate Q, having a less inclination. Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, there is an arch, R, of fire-brick. This arch, after having been heated to a considerable degree by the fire on the grate, will radiate heat on the fresh fuel while it may be passing down the plane P, and thus will aid in causing the decomposition and volatilization of the fuel, which will be afterward completed by the fire in the furnace and by the atmospheric air which may enter through the grate Q. The air, on passing through the highly-heated fuel lying upon the grate, will be decomposed into carbonic acid gas, with a certain proportion of nitrogen. Afterward, on passing up through the thick layer of fuel in a less state of combustion or incandescence, it will become transformed into carbonic oxide, and in this state will pass over the surface of the fuel resting on the plane P, where it will mix with the
180 gases evolved from the same, and finally escape by the passage S, and into the verticle pipe P, leading into the conduit

U, by which it will be conveyed to the regenerators. The aperture V, at the top of the generator, is to enable a person to introduce a poker into the fuel for the purpose of stirring it from time to time. A valve *w*, in the pipe T, answers to close the latter as occasion may require. By means of a pipe *k*, leading into a conductor *i*, water may be led into the generator in a small stream. This small current of water, falling on the fuel, becomes vaporized. The vapor, acting on any hot particles of carbon rising up with the gases, will combine with the same and form two combustible gases, viz, carbonic oxide and hydrogen.

We do not confine our invention to the employment of this specific form or kind of gas generator, as there may be others which may be employed to good advantage, the whole depending on circumstances. By means of the gas generator, or, in other words, by decomposing the solid fuel, such as coal, lignite, peat, etc., by means of a separate apparatus, we not only avoid the introduction of such fuel into the furnace, but we are enabled to heat the gas to a high degree and to mix it with heated air preparatory to its being conducted into the furnace or place designed for its combustion and to be heated thereby. By the absence of any solid carbon or ashes in the working chamber of the furnace operations may be carried on in an open furnace, which hitherto it has only been possible to conduct in covered vessels or pots. Thus we can melt flint, extra white, and other superior qualities of glass in open pots, fire pottery, without inclosing the same in "saggers," or melt steel and other substances upon an open bed or hearth without injury. It is also important in many operations that the state of pressure of the gases in the furnace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmosphere in order to prevent the egress of flame from or the ingress of air into the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron. For this purpose we arrange with the furnace four regenerators, as hereinafter described, and to operate as before specified.

In some cases, however, where no great heat may be re-
181 quired, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four regenetators.

In applying our improvements to glass furnaces we find it sometimes advantageous to melt the materials composing the glass in open pots, and to cover the latter with movable lids while working the metal out in the usual way. When it is required to accomplish secondary operations in separare furnaces—for instance, to heat annealing furnaces or "lears" in the manufacture of glass—we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire-clay or other refractory material are to be provided in that case to these channels to regulate the flow of the

gases, according to the direction in which the main furnace may be working, or we draw off the mixed gases, in a state of combustion, from the principal furnace.

In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces, side by side, and only one set of four regenerators, which, by means of slides or valves of fire-clay or other proper refractory material, can be made to communicate at intervals with one heated furnace or the other. During the time that one furnace is fired the other is to be allowed to cool, to be discharged and charged again with fresh material, and *vice versa*. The regenerators may thus always be kept in working condition. Or we arrange four or more chambers in such way that they themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns, to be fired or discharged.

In the drawings (Figs. 1, 2, 3, 4, 5, 6, and 7) A is the furnace, of which *a* is the bed and *b* the crown or arch and *c* the mouth. Beneath the bed of the furnace are the four regenerators B^1 B^2 B^3 B^4 each consisting in part of a chamber erected of fire-brick or other suitable material and having a grating, *c'*, extending across its lower part, and constituting part of the upper portion of an arched passage, H, I, K, or L, arranged underneath such chamber. Upon this grating is a pile, *d*, of fire-
182 bricks or other heat-absorbing and indestructible materials, the same being arranged or stacked in such manner as to leave interstices or spaces between them, so as to enable the air or gas, while passing through the pile, to come in contact with the surfaces of the several parts or bricks thereof. Each of the said regenerators is arched or closed over at its top, and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or *f'*, as shown in the drawings. The two passages *f f'* lead out of the furnace A in opposite directions, and from opposite ends thereof. Directly underneath the bed of the furnace A, and between it and the tops of the two inner regenerators B^2 and B^3, there is an air chamber or space, C, which should communicate freely, at its opposite sides or ends, with the atmosphere, in order that a current of cool air may be caused to continually pass through it, for the purpose of maintaining the bed of the furnace, as well as the arches of the regenerators B^2 B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators while they may be in operation. In rear of the upper parts of the regenerators, and below the furnace, there is an air space or chamber, D, which at intervals is bridged, as shown at *g g g*. There is also below the space D a sunken space or chamber, E, in which are situated the levers for working the dampers of the apparatus. In front of the space E there is a passage, F (see Fig. 6), which continues horizontally in opposite directions, and thence drops downward, and at its two extremities opens respectively into the two passages H and L, which extend underneath the two outermost

regenerators. Each of these passages H I K L is to be closed at both of its ends, but the two middle passages I K are shown in Fig. 4 as open at their rear ends. These middle passages, however, with vertical continuations of them leading into a horizontal passage, N, are, as well as the said passage N, to be walled up or covered in rear. The same may be said with respect to a gas tube or passage, O′, which is to lead from the generator and into the passage N, as shown in Figs. 3 and 4. Between the two passages I K there is a smoke flue, P, into the rear part of which there is an opening, Q′, leading from the passage F, or a damper case, R, arranged vertically therein, and having a damper, S′, arranged within it, and so
183 as to be capable of being turned by a lever, *h*. There is another such damper case, T′, applied in the passage N, and opening at its opposite sides into such passage, and also at its top into the generator conduit or gas flue O′. Within the case T′ there is a damper, U, capable of being turned by a lever, *i*. Situated over each of the damper cases there is a valve opening, V′ or W′, provided with a valve, X or Y, the whole being arranged as shown in Figs. 3 and 4.

By means of the damper U gas from the passage O′ may be led into either of the passages I K, it being cut off from passing into one while it may be passing into the other. So by means of the damper S′ air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other. The valve Y will serve to arrest the flowage of air into the passage F. So with the valve X it will answer to close off the passage of gas into the damper case immediately underneath it.

The operation of the said apparatus having been hereinbefore substantially described, we now proceed to point out what we claim as our invention; that is to say:

We claim, in combination with a furnace, A, and its chimney or smoke-discharge flue P, a system or series of air and gas regenerators B^1 B^2 B^3 B^4, constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace and out of the chimney, in manner and so as to be operated as and for the purpose or purposes hereinbefore described.

We also claim the arrangement and combination of the air space or open chamber C with the furnace and its system of regenerators, arranged and applied together substantially in manner and so as to operate as described.

We also claim the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified.

We also claim the combination of a furnace with one or more regenerators or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom, and also with means or devices by which all or a portion of the heat so inter-

cepted or received may be absorbed by the influent air or gas
184 during its passage into or to such furnace, for the purpose of improving or promoting combustion therein.

C. W. SIEMENS.
FRED. SIEMENS.

Witnesses as to C. W. Siemens—
EDW'D N. HOBBS,
THOS. TANNER,
Both of 2 Pope's-Head Alley, Cornhill, London, Gentlemen.

Witnesses as to Frederick Siemens—
OSWOLD ROETHIG,
PAUL DRUCKMÜLLER,
Of Dresden.

(Here follow diagrams marked pp. 185*a*, 185*b*, 185*c*, 185*d*.)

186 DEFENDANTS' EXHIBIT "COMPLAINANTS' ORIGINAL AMERICAN PATENT." C. F. Z., Sp. Ex. March 29, 1882.

(65.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the letters patent granted C. W. and F. Siemens, dated March 1, 1864, No. 41788, for "Improved regenerator furnaces."

In testimony whereof I, W. H. Doolittle, acting Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed, this eighteenth day of February, in the year of our Lord one thousand eight hundred and seventy-eight, and of the Independence of the United States the one hundred and second.

[SEAL.] W. H. DOOLITTLE,
Acting Commissioner.

No. 41788.

UNITED STATES OF AMERICA:

To all to whom these letters patent shall come:

Whereas Charles William and Frederick Siemens, of London, England, have alleged that they have invented a new and useful improved regenerator furnace, which they state has not been known or used before their application, have made oath, said C. W. Siemens that he is a subject of Great Britain, and said F. Siemens that
187 he is a subject of the Grand Duke of Mecklenburg-Strelitz, in Germany; that they do verily believe that they are the original and first inventors or discoverer of the said invention, and that the same has not, to the best of their knowledge and belief, been previously known or used; have paid into the Treasury of the United States the sum of thirty-five dollars, and presented a petition

to the Commissioner of Patents signifying a desire of obtaining an exclusive property in the said invention, and praying that a patent may be granted for that purpose:

These are, therefore, to grant, according to law, to the said C. W. and F. Siemens, their heirs, administrators, or assigns, for the term of seventeen years from the first day of March, one thousand eight hundred and sixty-four, the full and exclusive right and liberty of making, constructing, using, and vending to others to be used the said invention, a description whereof is given in the words of the said C. W. and F. Siemens in the schedule hereunto annexed and is made part of these presents.

In testimony whereof I have caused these letters to be made patent and the seal of the Patent Office has been hereunto affixed.

Given under my hand, at the city of Washington, this first day of March, in the year of our Lord one thousand eight hundred and sixty-four, and of the Independence of the United States of America the eighty-eighth.

[SEAL.]

J. P. USHER,
Secretary of the Interior.

Countersigned and sealed with the seal of the Patent Office.

D. P. HOLLOWAY,
Commissioner of Patents.

The Schedule Referred to in these Letters Patent and Making Part of the Same.

To all persons to whom these presents shall come:

Be it known that we, Charles William Siemens and Frederick Siemens (residents of Great George street, Westminster, in or near the city of London, of the kingdom of Great Britain) have 188 made a new and useful invention, having reference to furnaces of various kinds, and we do hereby declare the same to be fully described in the following specification and represented in the accompanying drawings, of which—

Figure 1 is a top view;

Figure 2, a longitudinal section;

Figure 3, a transverse section;

Figure 4, a rear elevation, and

Figure 5 a front elevation of a pudding furnace with our said invention applied to it.

Figure 3 is a longitudinal section taken through the air-valves and passages of the two outermost or air regenerators, to be hereinafter described.

Figure 7 is a transverse section taken through one of the outermost regenerators.

The object of our invention is not only to economize heat or to save and utilize much of it that is generally wasted by being allowed to escape into and through the chimney of a furnace, but to produce heat by the combusion of gases and atmospheric air in mixture, the gases being derived from coal or other fuel by a furnace

such as we shall hereinafter explain, or by any other suitable means or apparatus.

In carrying out our invention in its application to a furnace for puddling iron, or for any other purpose where the furnace is to be heated to a high degree, we arrange four of what we term the "regenerators" below the level of the bed of the furnace, and when all or any of them may be placed immediately underneath the furnace, we form underneath the latter a space for the circulation of cold air, the top of the regenerator or regenerators which may be immediately underneath such space being duly covered.

Passages lead from the upper part of two of these regenerators into the furnace, or into a channel or passage communicating with one end thereof. Similar passages lead from the two remaining regenerators and in a similar manner communicate with the opposite end of the furnace. The lower parts of the four regenerators have passages leading into them respectively. To one of the regenerators of each pair, at either end of the furnace, the passage leading into its lower part is to open into the atmosphere, so as to supply the regenerator with atmospheric air. The passage leading into the lower part of the other regenerator of the pair is a gas con-
189 duit for supplying its regenerator with gas. The several passages communicate with a flue or chimney, and have valves and reversing dampers, by means of which currents of air and combustible gas or gases may be directed through the furnace and the whole system of regenerators in the following manner:

A current of air is to be caused to flow into the lower part and up through one of the regenerators of one of the two pairs of them. At the same time a current of gas is to be made to flow into the lower part of the other regenerator of such pair. After ascending through their regenerators, or between the bricks of the mass of loosely-piled brick work or other refractory material making part of such regenerator, the said aerial and gaseous currents unite and flow into the furnace, where they are to be fired. The heated volatile products or spent gases resulting from the combustion of the said currents of air and gas will flow out of the furnace and into and down through the two remaining regenerators, and after circulating through the masses of brick work or refractory material of which such regenerators are composed in part, the said spent products will be directed into and will escape by the chimney.

When the last two regenerators may have been sufficiently heated, the direction of the aerial and gaseous currents is to be reversed; that is to say, the currents of air and gas are to be caused to enter the two last-mentioned regenerators separately; that is to say, air is to pass into one and the gas into the other. In ascending through the regenerators the air and gas will be heated, or will absorb from the masses of brick work much of the heat previously imparted to them, after which the two currents will unite and flow into the furnace, and there will be inflamed, and will produce a flame of very great intensity or heat. The spent products of combustion will flow out of the furnace, and thence down through the remaining two regenerators, and after imparting their heat to them, or having it

more or less abstracted by them, will be directed into and caused to escape by the chimney. The supplying aerial and gaseous currents are thus to be thrown through the pairs of regenerators alternately, their combustible products escaping through the discharging pair and serving to heat them, while they in turn serve to heat the aerial and gaseous currents when caused to flow through them.

Before proceeding to more fully describe our invention, we
190 will explain a gas generator such as may be employed in connection therewith, the said generator being shown in vertical section in figure 8. One or more of these generators may be used in connection with a conduit or conduits for the conveyance of the gas to the regenerators.

In this gas generator O is a hopper or induct, into and through which the coal or fuel is to be introduced, the said hopper being closed by means of a cover, *a*, after it may have received a supply of fuel. From the hopper the fuel descends an inclined plane, P, composed of fire-brick or other proper refractory or heat-resisting material, it being inclined at an angle of about forty-five degrees to the horizon. From thence the fuel passes upon a fire-grate, Q, having a less inclination. Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, there is an arch, R, of fire-brick. This arch, after having been heated to a considerable degree by the fire on the grate, will radiate heat on the fresh fuel while it may be passing down the plane P, and thus will aid in causing the decomposition and volatilization of the fuel, which will be afterwards completed by the fire in the furnace and by the atmospheric air which may enter through the grate Q. The air on passing through the highly heated fuel lying upon the grate will be decomposed into carbonic acid gas, with a certain proportion of nitrogen. Afterward, on passing up through the thick layer of fuel in a less state of combustion or incandescence, it will become transformed into carbonic oxide, and in this state will pass over the surface of the fuel resting on the plane P, where it will mix with the gases evolved from the same, and finally escape by the passage S and into the vertical pipe T, leading into the conduit V, by which it will be conveyed to the regenerators.

The aperture V at the top of the generator is to enable a person to introduce a poker into the fuel for the purpose of stirring it from time to time. A valve, *w*, in the pipe T answers to close the latter as occasion may require. By means of a pipe, *k*, leading into a conductor, *i*, water may be led into the generator in a small stream. This small current of water falling on the fuel becomes vaporized. The vapor, acting on any hot particles of carbon rising up with the gases, will combine with the same and form two combustible gases, viz., carbonic oxide and hydrogen.

191 We do not confine our invention to the employment of this specific form or kind of gas generator, as there may be others which may be employed to good advantage, the whole depending on circumstances. By means of the gas generator, or, in other words, by decomposing the solid fuel, such as coal, lignite, peat, etc.,

by means of a separate apparatus, we not only avoid the introduction of such fuel into the furnace, but we are enabled to heat the gas to a high degree, and to mix it with heated air, preparatory to its being conducted into the furnace or place designed for its combustion, and to be heated thereby. By the absence of any solid carbon or ashes in the working chamber of the furnace, operations may be carried on in an open furnace, which hitherto it has only been possible to conduct in covered vessels or pots. Thus we can melt flint, extra white, and other superior qualities of glass in open pots, fire pottery, without inclosing the same in "saggers," or melt steel and other substances upon an open bed or hearth without injury.

It is also important in many operations that the state of pressure of the gases in the furnace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmosphere, in order to prevent the egress of flame from or the ingress of air into the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron. For this purpose we arrange with the furnace four regenerators, as hereinafter described, and to operate as before specified. In some cases, however, where no great heat may be required, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four regenerators.

In applying our improvements to glass furnaces, we find it sometimes advantageous to melt the materials composing the glass in open pots, and to cover the latter with movable lids whilst working the metal out in the usual way.

When it is required to accomplish secondary operations in separate furnaces—for instance, to heat annealing furnaces or "lears" in the manufacture of glass—we accomplish this without providing
192 separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire clay or other refractory material are to be provided in that case to these channels to regulate the flow of the gases, according to the direction in which the main furnace may be working, or we draw off the mixed gases, in a state of combustion, from the principal furnace. In firing pottery-ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces side by side, and only one set of four regenerators, which, by means of slides or valves of fire clay or other proper refractory material, can be made to communicate at intervals with one heated furnace or the other. During the time that one furnace is fired the other is to be allowed to cool, to be discharged and charged again with fresh material, and *vice versa*. The regenerators may thus always be kept in working condition, or we arrange four or more chambers in such way that they

themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns to be fired or discharged.

In the drawings (figures 1, 2, 3, 4, 5, 6, and 7) A is the furnace, of which *a* is the bed, and *b* the crown or arch, and *c* the mouth. Beneath the bed of the furnace are the four regenerators B^1 B^2 B^3 B^4, each consisting in part of a chamber erected of fire brick or other suitable material, and having a grating, *c'*, extending across its lower part, and constituting part of the upper portion of an arched passage, H, I, K, or L, arranged underneath such chamber. Upon this grating is a pile, *d*, of fire bricks or other heat-absorbing and indestructible materials, the same being arranged or stacked in such manner as to leave interstices or spaces between them, so as to enable the air or gas while passing through the pile to come in contact with the surfaces of the several parts or bricks thereof. Each of the said regenerators is arched or closed over at its top, and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or *f'*, as shown in the drawings. The two passages *f f'* lead out of the furnace A in opposite directions, and from opposite ends thereof. Directly underneath the bed of the furnace A, and
193 between it and the tops of the two inner regenerators B^2 and B^3, there is an air chamber or space, C, which should communicate freely, at its opposite sides or ends, with the atmosphere, in order that a current of cool air may be caused to continually pass through it, for the purpose of maintaining the bed of the furnace, as well as the arches of the regenerators B^2 B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators while they may be in operation.

In rear of the upper parts of the regenerators and below the furnace there is an air space or chamber, D, which at intervals is bridged, as shown at *g g g*. There is also below the space D a sunken space or chamber, E, in which are situated the levers for working the dampers of the apparatus. In front of the space E there is a passage, F (see figure 6), which continues horizontally in opposite directions, and thence drops downward, and at its two extremities opens respectively into the two passages H and L, which extend underneath the two outermost regenerators. Each of these passages H I K L is to be closed at both of its ends, but the two middle passages, I K, are shown in figure 4 as open at their rear ends. These middle passages, however, with vertical continuations of them leading into a horizontal passage, N, are, as well as the said passage N, to be walled up or covered in rear. The same may be said with respect to a gas tube or passage, O', which is to lead from the generator and into the passage N, as shown in figures 3 and 4.

Between the two passages I K there is a smoke flue, P, into the rear part of which there is an opening, Q', leading from the passage F, or a damper case, R, arranged vertically therein, and having a damper, S', arranged within it, and so as to be capable of being turned by a lever, *h*.

There is another such damper case, T', applied in the passage N, and opening at its opposite sides into such passage, and also at its top into the generator conduit or gas flue O'. Within the case T'

there is a damper, U, capable of being turned by a lever *i*. Situated over each of the damper cases there is a valve opening, V′ or W′, provided with a valve, X or Y, the whole being arranged as shown in figures 3 and 4.

By means of the damper U gas from the passage O′ may be led into either of the passages I K, it being cut off from passing
194 into one while it may be passing into the other. So, by means of the damper S′ air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other. The valve Y will serve to arrest the flowage of air into the passage F. So with the valve X it will answer to close off the passage of gas into the damper case immediately underneath it.

The operation of the said apparatus having been hereinbefore substantially described, we now proceed to point out what we claim as our invention—that is to say:

We claim, in combination with a furnace, A, and its chimney or smoke-discharge flue, P, a system or series of air and gas regenerators, B^1 B^2 B^3 B^4, constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace and out of the chimney, in manner and so as to be operated as and for the purpose or purposes hereinbefore described.

We also claim the arrangement and combination of the air space or open chamber C, with the furnace and its system of regenerators arranged and applied together substantially in manner and so as to operate as described.

We also claim the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified.

CHARLES WILLIAM SIEMENS.
FREDERICK SIEMENS.

Witnesses:
ROBT. LINKSON.
G. A. BRYANT.

Ex'd: H. M. H., E. A. M.

195 DEFENDANTS' EXHIBIT COMPLAINANTS' APPLICATION FOR REISSUE No. 3265. C. F. Z., Sp. Ex., March 29, 1882.

(65.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file wrapper and contents in the matter of the reissue letters patent granted Charles William Siemens and Frederick Siemens, dated January 12th, 1869, No. 3265, for "improved regenerator furnace for metallurgists and others."

In testimony whereof I, W. H. Doolittle, Acting Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this twenty-first day of February, in the year of our Lord one thousand eight hundred and seventy-eight, and of the Independence of the United States the one hundred and second.

[SEAL.] W. H. DOOLITTLE,
Acting Commissioner.

To the Commissioner of Patents of the United States of America:

The petition of Charles William and Frederick Siemens, of Westminster, in the county of Middlesex, and State of England, respectfully represents that they obtain- letters patent of the United States for an invention having reference to furnaces, which letters
196 patent are dated March 1st, 1864; that they believe the same are inoperative and invalid by reason of a defective specification, which defect has arisen from inadvertence, accident, or mistake. They, therefore, pray that they may be allowed to surrender the same, and request that new letters patent may issue to them for the remainder of the term for which the original patent was granted under the amended specification herewith presented, and having paid thirty dollars into the Treasury of the United States, and complied with all the other conditions expressed in the acts of Congress for such cases made and provided.

Signed at ——, in the State of ——, England, the — day of September, in the year of our Lord eighteen hundred and sixty-eight.

C. W. SIEMENS.
FREDERICK SIEMENS.

To the Commissioner of Patents of the United States of America.

SIR: Having invented a new and useful improvement in furnaces, for which letters patent were granted to us on the first day of March, A. D. 1864, and having surrendered the same, and executed an application for new letters patent of the United States of America, therefore we do hereby appoint, and request you will recognize, R. H. Eddy, solicitor of patents, of Boston, in the State of Massachusetts, to be our true, sufficient, and lawful attorney for us and in our name to attend to procuring and receiving the said letters patent, and to alter and amend our specifications, drawings, and claims previous to the said letters patent being granted, in whatever way, manner, and extent he, the said Eddy, may consider most desirable for our interest, and to execute and deliver any papers, and generally to do and perform all such acts, matters, and things as may be necessary for the complete and effectual obtaining of the said letters patent, or for the withdrawal of any money, papers, drawings, or models connected with the application should he at any time deem such withdrawal advisable. In case of such withdrawal of any such money the Commissioner of Patents or the Treasurer of the
197 United States is hereby authorized to pay to the said Eddy for us, and the said Eddy is empowered to receive for us, such sum of money.

Signed at ——, England, the eighth day of October, A. D. 1868.

C. W. SIEMENS.
FREDERICK SIEMENS.

Witness: A. B.

Witness to the signature of C. W. Siemens—
W. WACKALY.

Witness to the signature of Frederick Siemens—
W. KNOOP, [SEAL.]
Vice-Consul of the United States of America at Dresden.

To all persons to whom these presents shall come:

Be it known that we, Charles William Siemens and Frederick Siemens (residents of Great George street, Westminster, in or near the city of London, of the Kingdom of Great Britain), have made a new and useful invention having reference to furnaces of various kinds; and we do hereby declare the same to be fully described in the following specification and represented in the accompanying drawings, of which—

Figure 1 is a top view;
Figure 2, a longitudinal section;
Figure 3, a transverse section;
Figure 4, a rear elevation; and
Figure 5, a front elevation of a puddling furnace with our said invention applied to it.

Figure 6 is a longitudinal section taken through the air valves and passages of the two outermost or air regenerators, to be hereinafter described.

Figure 7 is a transverse section taken through one of the outermost regenerators.

The object of our invention is not only to economize heat, or to save and utilize much of it that is generally wasted by being allowed to escape into and through the chimney of a furnace, but to produce heat by the combustion of gases and atmospheric air in mixture, the gases being derived from coal or other fuel by a furnace such as we shall hereinafter explain, or by any other suitable means or apparatus.

In carrying out our invention in its application to a furnace
198 for puddling iron, or for any other purpose where the furnace is to be heated to a high degree, we arrange four of what we term the "regenerators" below the level of the bed of the furnace, and when all or any of them may be placed immediately underneath the furnace, we form underneath the latter a space for the circulation of cold air, the top of the regenerator or regenerators which may be immediately underneath, such space being covered.

Passages lead from the upper part of two of these regenerators into the furnace, or into a channel or passage communicating with one end thereof. Similar passages lead from the two remaining regenerators, and in a similar manner communicate with the opposite end of the furnace.

The lower parts of the four regenerators have passages leading into them respectively. To one of the regenerators of each pair, at either end of the furnace, the passage leading into its lower part is to open into the atmosphere so as to supply the regenerator with atmospheric air. The passage leading into the lower part of the other regenerator of the pair is a gas conduit for supplying its regenerator with gas.

The several passages communicate with a flue or chimney, and have valves and reversing dampers, by means of which currents of air and combustible gas or gases may be directed through the furnace and the whole system of regenerators in the following manner:

A current of air is to be caused to flow into the lower part and up through one of the regenerators of one of the two pairs of them. At the same time a current of gas is to be made to flow into the lower part of the other regenerator of such pair. After ascending through their regenerators, or between the bricks of the mass of loosely-piled brick work or other refractory material making part of such regenerator, the said aerial and gaseous currents unite and flow into the furnace where they are to be fired.

The heated volatile products or spent gases resulting from the combustion of said currents of air and gas will flow out of the furnace and into and down through the two remaining regenerators, and after circulating through the masses of brick work or refractory material of which such regenerators are composed in part, the said spent products will be directed into and will escape by the chimney.

199 When the last two regenerators may have been sufficiently heated the direction of the aerial and gaseous currents is to reversed; that is to say, the currents of air and gas are to be caused to enter the two last-mentioned regenerators separately; that is to say, air is to pass into one and gas into the other.

In ascending through the regenerators the air and gas will be heated or will absorb from the masses of brick work much of the heat previously imparted to them, after which the two currents will unite and flow into the furnace and there will be inflamed, and will produce a flame of very great intensity of heat. The spent products of the combustion will flow out of the furnace and thence down through the remaining two regenerators, and after imparting their heat to them, or having it more or less abstracted by them will be directed into and caused to escape by the chimney. The supplying aerial and gaseous currents are thus to be thrown through the pairs of regenerators alternately, their combustible products escaping through the discharging pair and serving to heat them, while they in turn serve to heat the aerial and gaseous currents when caused to flow through them.

Before proceeding to more fully describe our invention we will explain a gas generator, such as may be employed in connection therewith, the said generator being shown in vertical sections in figure 8. One or more of these generators may be used in connec-

tion with a conduit or conduits for the conveyance of gas to the regenerators.

In this gas generator O is a hopper or induct, into and through which the coal or fuel is to be introduced, the said hopper being closed by means of a cover, *a*, after it may have received a supply of fuel.

From the hopper the fuel descends an inclined plane P, composed of fire-brick or other proper refractory or heat-resisting material, it being inclined at an angle of about forty-five degrees to the horizon. From thence the fuel passes upon a fire grate, Q, having a less inclination. Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, there is an arch, R, of fire-brick. This arch, after having been heated to a considerable degree of heat by the fire on the grate, will radiate heat on the fresh fuel while it may be passing down the plane P, and thus will aid in causing the decomposition and volatilization of the fuel which will be afterward
200 completed by the fire in the furnace, and by the atmospheric air which may enter through the grate Q. The air on passing through the highly-heated fuel lying upon the grate will be decomposed into carbonic acid gas with a certain proportion of nitrogen. Afterward, on passing up through the thick layer of fuel in a less state of combustion or incandescence, it will become transformed into carbonic oxide, and in this state will pass over the surface of the fuel resting on the plane P, where it will mix with the gases evolved from the same, and finally escape by the passage S, and into the vertical pipe T, leading into the conduit U, by which it which it will be conveyed to the regenerators.

The aperture V at the top of the generator is to enable a person to introduce a poker into the fuel for the purpose of stirring it from time to time. A valve, *w*, in the pipe T answers to close the latter as occasion may require. By means of a pipe, *k*, leading into conductor, *i*, water may be led into the generator in a small stream. This small current of water falling on the fuel becomes vaporized. The vapor acting on any hot particles of carbon rising up with the gases will combine with the same and form two combustible gases, viz, carbonic oxide and hydrogen.

We do not confine our invention to the employment of this specific form or kind of gas generator, as there may be others which may be employed to good advantage, the whole depending on circumstances. By means of the gas generator, or, in other words, by decomposing the solid fuel, such as coal, lignite, peat, etc., by means of a separate apparatus, we not only avoid the introduction of such fuel into the furnace, but we are enabled to heat the gas to a high degree and to mix it with heated air, preparatory to its being conducted into the furnace or place designed for its combustion, and to be heated thereby. By the absence of any solid carbon or ashes in the working chamber of the furnace, operations may be carried on in an open furnace which hitherto it has only been possible to conduct in covered vessels or pots.

Thus we can melt flint, extra white, and other superior qualities of glass in open pots, fire pottery without enclosing the same in

"saggers," or melt steel and other substances upon an open bed or hearth without injury.

It is also important in many operations that the state of pressure of the gases in the furnace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmosphere, in order to prevent the egress of flame from, or the ingress of air into, the furnace by opening aperatures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron. For this purpose we arrange with the furnace four regenerators, as hereinafter described, and to operate as before specified.

In some cases, however, where no great heat is required, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four regenerators.

In applying our improvements to glass furnaces we find it sometimes advantageous to melt the materials composing the glass in open pots, and to cover the latter with movable lids whilst working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces—for instance, to heat annealing furnaces or "lears" in the manufacture of glass—we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire clay or other refractory material are to be provided in that case to these channels to regulate the flow of the gases, according to the direction in which the main furnace may be working, or we draw off the mixed gases, in a state of combustion, from the principal furnace.

In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces, side by side, and only one set of four regenerators, which, by means of slides or valves of fire-clay or other proper refractory material, can be made to communicate at intervals with one heated furnace or the other. During the time that one furnace is fired the other is to be allowed to cool to be discharged, and charged again with fresh material, and *vice versa*. The regenerators may thus always be kept in working condition; or we arrange four or more chambers in such way that they themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns to be fired or discharged.

In the drawings, (figures 1, 2, 3, 4, 5, 6, and 7,) A is the furnace, of which *a* is the bed, and *b* the crown or arch, and *c* the mouth. Beneath the bed of the furnace are the four regenerators B^1 B^2 B^3 B^4, each consisting, in part, of a chamber erected of firebrick or other suitable material, and having a grating, *c'*, extending across it lower part and constituting part of the upper portion of an arched passage

(H, I, K, or L,) arranged underneath such chamber. Upon this grating a pile, *d*, of fire-bricks or other heat-absorbing and indestructible materials, the same being arranged or stacked in such manner as to leave interstices or spaces between them, so as to enable the air or gas, while passing through the pile, to come in contact with the surfaces of the several parts or bricks thereof. Each of the said regenerators is arched or closed over at its top and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or *f'*, as shown in the drawings. The two passages of *f f'* lead out of the furnace A in opposite directions and from opposite ends thereof.

Directly underneath the bed of the furnace A, and between it and the tops of the two inner regenerators B^2 and B^3, there is an air-chamber or space C, which should communicate freely at its opposite sides or ends with the atmosphere, in order that a current of cool air may be caused to continually pass through it for the purpose of maintaining the bed of the furnace, as well as the arches of the regenerators B^2 B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators, while they may be in operation.

In rear of the upper parts of the regenerators and below the furnace, there is an air space or chamber D, which, at intervals, is bridged, as shown at *g g g*.

There is, also, below the space D a sunken space or chamber, E, in which are situated the levers for working the dampers of the apparatus. In front of the space E there is a passage, F, (see figure 6,) which continues horizontally in opposite directions, and thence drops downward, and at its two extremities opens, respectively, into the two passages H and L, which extend underneath the two outermost regenerators. Each of these passages H I K
203 L is to be closed at both of its ends, but the two middle passages I K are shown in figure 4 as open at their rear ends. These middle passages, however, with vertical continuations of them leading into a horizontal passage, N, are, as well as the said passage N, to be walled up or covered in rear. The same may be said with respect to a gas-tube or passage, O', which is to lead from the generator and into the passage N, as shown in figures 3 and 4.

Between the two passages I K there is a smoke-flue, P, into the rear part of which there is an opening, Q', leading from the passage F, or a damper-case, R, arranged vertically therein, and having a damper, S', arranged within it, and so as to be capable of being turned by a lever, *h*.

There is another such damper-case, T', applied in the passage N, and opening at its opposite sides into such passage, and also at its top into the generator-conduit or gas flue O'. Within the case T' there is a damper U, capable of being turned by a lever, *i*. Situated over each of the damper-cases there is a valve-opening, V' or W', provided with a valve, X or Y, the whole being arranged as shown in figures 3 and 4.

By means of the damper U gas from the passage O' may be led into either of the passages I K, it being cut off from passing into

one while it may be passing into the other. So, by means of the damper S^1, air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other. The valve Y will serve to arrest the flowage of air into the passage F. So, with the valve X, it will answer to close off the passage of gas into the damper case immediately underneath it.

The operation of the said apparatus having been hereinbefore substantially described, we now proceed to point out what we claim as our invention—that is to say:

We claim, in combination with a furnace (A) and its chimney or smoke discharge flue (P) a system or series of air and gas regenerators (B^1 B^2 B^3 B^4,) constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace, and out of the chimney, in manner and so as to be operated as and for the purpose or purposes hereinbefore described.

We also claim the arrangement and combination of the air
204 space or open chamber (C) with the furnace and its system of regenerators, arranged and applied together, substantially in manner and so as to operate as described.

We also claim the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified.

We also claim the combination of a furnace with one or more regenerators or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom, and also with means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas during its passage into or to such furnace, for the purpose of improving or promoting combustion therein.

C. W. SIEMENS.
FRED. SIEMENS.

Witnesses as to C. W. Siemens—
EDW'D N. HOBBS,
THOS. TANNER,
Both of 2 *Pope's-Head Alley, Cornhill, London, Gent'n.*

As to Frederick Siemens—
OSWALD ROETHIG,
PAUL DRUCKMÜLLER.
Of Dresden.

COUNTY OF MIDDLESEX, ENGLAND:

On this twelfth day of October, A. D. 1868, personally appeared before me the above-named Charles William and Frederick Siemens, and made solemn oath that they verily believe that by reason of a defective specification and claim, letters patent No. 41,788, for improved regenerator furnaces, as granted to them on the first day of March, A. D. 1864, are not fully valid and available to them, and that such error has arisen from inadvertence, accident, or mistake and without any fraudulent intention, to the best of their knowledge and belief.

UNITED STATES CONSULATE, } ss:
Dresden, Kingdom of Saxony, }

On this twentieth day of October, A. D. 1868, before me, William Knoop, vice-consul of the United States of America at the
205 city of Dresden, Kingdom of Saxony, personally appeared Frederick Siemens, and made solemn oath that he verily believes that by a reason of a defective specification and claim, letters patent No. 41788, for improved regenerator furnaces, as granted to himself and Charles William Siemens on the first day of March, A. D. 1864, are not fully valid and available to them, and that such error has arisen from inadvertence, accident, or mistake, and without any fraudulent intention, to the best of his knowledge and belief.

In testimony whereof I have hereunto set my hand and seal of office, at Dresden, Saxony, aforesaid, the day and year above written.

[SEAL.] W. KNOOP,
Vice-Consul of the United States of America.

COUNTY OF MIDDLESEX, ENGLAND:

Be it known that on this twelfth day of October, in the year of our Lord one thousand eight hundred and sixty-eight, personally appeared before me, William Webb Venn, Jr., of the city of London, notary public public by royal authority, duly admitted and sworn, Charles William Siemens, named and described in the annexed specification and claim, and made solemn oath that he verily believes that by reason of a defective specification and claim, letters patent No. 41788, for improved regenerator furnaces, as granted to himself and Frederick Siemens on the first day of March, A. D. (1864) one thousand eight hundred and sixty-four, are not fully valid and available to them, and that such error has arisen from inadvertence, accident, or mistake, and without any fraudulent intention, to the best of his knowledge and belief.

In testimony whereof I have hereunto set my hand and seal of office, and have caused the specification and claim above mentioned to be hereunto annexed, dated in London the day, month, and year first above written, etc.

Quod attestor.

[SEAL.] W. W. VENN, JR.,
Notary Public.

CONSULATE OF THE UNITED STATES OF AMERICA, AT LONDON:

I, Joshua Nunn, deputy counsel of the United States of America for London and the dependencies thereof, do hereby make
206 known and certify to all whom it may concern that William Webb Venn, Jr., before whom the annexed affidavit of Charles William Siemens was made, as appears by his signature thereto, is a notary public, duly admitted and sworn, practising in the city of London aforesaid, and authorized to receive affidavits, and that to all acts by him so done full faith and credit are and ought to be given in judicature and thereout.

In testimony whereof I have hereunto set my hand and affixed the seal of the consulate of the United States at London aforesaid, this thirteenth day of October, in the year of our Lord one thousand eight hundred and sixty-eight, and in the ninety-third year of the Independence of the said United States.

[SEAL.] J. NUNN.

1068. HEDRICK.

Reissue 10037.

No. 3265.

Charles William Siemens and Frederick Siemens, of Westminster, county of England.

Regenerator Furnaces.

Rec'd Dec'r 23, 1868.
Petition, " " "
Affidavit, " " "
Specification, " " "
1 Drawing, 2 sheets " " "
Old patent, No. 41788, March 1, 1864.
1 Cert. dep., $30, Dec'r 23, 1868.
Cash.
Examined Dec. 31, '68, B. S. Hedrick.
2 Issue, Grinnell, Jan. 2, '69.
3 Patented March 1, 1864.
Reissued Jan. 12, 1869.

R. H. EDDY,
Boston, Mass.

Ex.: J. A. W., M. McK.

207 DEFENDANTS' EXHIBIT COMPLAINANTS' APPLICATION FOR ORIGINAL AMERICAN PATENT. C. F. Z., Sp. Ex., March 29, 1882.

(65.)

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the files of this office of the file wrapper and contents in the matter of the letters patent granted Charles W. and Frederick Siemens, dated March 1, 1864, No. 41788, for "improved regenerator furnaces."

In testimony whereof I. W. H. Doolittle, acting Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this twentieth day of February, in the year of our Lord one thousand eight hundred and seventy-eight, and of the Independence of the United States the one hundred and second.

[SEAL.] W. H. DOOLITTLE,
Acting Commissioner.

BOSTON, *Sept.* 15, 1863.

SIR: Herewith I send you all the papers and a Treas. cert. of $15 for the application of Chas. W. & F. Siemens for a patent for an imp. in furnaces.

The model will be sent to-day.

Yours, resp'y,

R. H. EDDY,
Pr. F. P. HALE, Jr.

Hon. D. P. Holloway, Com. Patents, Washington, D. C.

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Be it known that we, Charles William Siemens and Frederick Siemens (residents of Great George street, Westminster, in or near the city of London, of the Kingdom of Great Britain) have made a new and useful invention, having reference to furnaces of various kinds, and we do hereby declare the same to be fully described in the following specification, and represented in the accompanying drawings, of which—

Figure 1 is a top view;

Figure 2, a longitudinal section;

Figure 3, a transverse section;

Figure 4, a rear elevation, and

Figure 5 a front elevation of a puddling furnace with our said invention applied to it.

Figure 6 is a longitudinal section taken through the air valves and passages of the two outermost or air regenerators, to be hereinafter described.

Figure 7 is a transverse section taken through one of the outermost regenerators.

The object of our invention is not only to economize heat, or to save and utilize much of it that is generally wasted by being allowed to escape into and through the chimney of a furnace, but to produce heat by the combustion of gases and atmospheric air in mixture, the gases being derived from coal or other fuel by a furnace such as we shall hereinafter explain, or by any other suitable means or apparatus.

In carrying out our invention in its application to a furnace for puddling iron, or for any other purpose where the furnace is to be heated to a high degree, we arrange four of what we term the "regenerators" below the level of the bed of the furnace, and when all or any of them may be placed immediately underneath the furnace we form underneath the latter a space for the circulation of cold air, the top of the regenerator or regenerators which may be immediately underneath such space being duly covered.

Passages lead from the upper part of two of these regenerators into the furnace or into a channel or passage communicating with one end thereof. Similar passages lead from the two remaining regenerators, and in a similar manner communicate with the opposite end of the furnace.

The lower parts of the four regenerators have passages lead-
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The heated volatile products or spent gases resulting from the combustion of the said currents of air and gas will flow out of the furnace and into and down through the two remaining regenerators, and after circulating through the masses of brick-work or refractory material of which such regenerators are composed in part, the said spent products will be directed into and will escape by the chimney.

When the last two regenerators may have been sufficiently heated, the direction of the aerial and gaseous currents is to be reversed; that is to say, the currents of air and gas are to be caused to enter the two last-mentioned regenerators separately; that is to say, air is to pass into one and gas into the other. In ascending through the regenerators the air and gas will be heated, or will absorb from the masses of brick-work much of the heat previously imparted to them, after which the two currents will unite and flow into the furnace, and there will be enflamed and will produce a flame of very great intensity of heat. The spent products of combustion will flow out of the furnace, and thence down through the remaining two regenerators,
and after imparting their heat to them, or having it more or
210 less abstracted by them, will be directed into and caused to escape by the chimney. The supplying aerial and gaseous currents are thus to be thrown through the pairs of regenerators alternately, their combustible products escaping through the discharging pair and serving to heat them, while they in turn serve to heat the aerial and gaseous currents when caused to flow through them.

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In this gas generator, O, is a hopper, or induct, into and through

which the coal or fuel is to be introduced, the said hopper being closed by means of a cover, *a*, after it may have received a supply of fuel. From the hopper the fuel descends an inclined plane, P, composed of fire brick or other proper refractory or heat-resisting material, it being inclined at an angle of about forty-five degrees to the horizon. From thence the fuel passes upon a firegrate, Q, having a less inclination. Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, there is an arch, R, of fire brick. This arch, after having been heated to a considerable degree by the fire on the grate, will radiate heat on the fresh fuel while it may be passing down the plane P, and thus will aid in causing the decomposition and volatilization of the fuel, which will be afterwards completed by the fire in the furnace, and by the atmospheric air which may enter though the grate Q. The air, on passing through the highly heated fuel lying upon the grate, will be decomposed into carbonic acid gas, with a certain proportion of nitrogen. Afterward, on passing up through the thick layer of fuel in a less state of combustion or incandescence, it will become transformed into carbonic oxide, and in this state will pass over the surface of the fuel, resting on the plane P, where it will mix with the gases evolved from the same, and finally escape from the passage S, and into the vertical pipe T, leading into the conduit U, by by which it will be conveyed to the regenerators.

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atmosphere, in order to prevent the egress of flame from, or the ingress of air into, the furnace, on the opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron. For this purpose we arrange with the furnace four regenerators, as hereinafter described, and to operate as before specified. In some cases, however, where no great heat may be required, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four regenerators.

In applying our improvements to glass furnaces, we find it
212 sometimes advantageous to melt the materials composing the glass in open pots, and to cover the latter with movable lids whilst working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces—for instance, to heat annealing furnaces or "lears" in the manufacture of glass—we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire-clay or other refractory material are to be provided in that case to these channels to regulate the flow of the gases, according to the direction in which the main furnace may be working, or we draw off the mixed gases, in a state of combustion, from the principal furnace. In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces side by side, and only one set of four regenerators, which, by means of slides or valves of fire-clay, or other proper refractory material, can be made to communicate at intervals with one heated furnace or the other. During the time that one furnace is fired the other is to be allowed to cool, to be discharged, and charged again with fresh material, and *vice versa*. The regenerators may thus always be kept in working condition; or we arrange four or more chambers in such way that they themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns to be fired or discharged.

In the drawings (figures 1, 2, 3, 4, 5, 6, and 7) A is the furnace, of which *a* is the bed, and *b* the crown or arch, and *c* the mouth. Beneath the bed of the furnace are the four regenerators B^1 B^2 B^3 B^4, each consisting in part of a chamber erected of fire-brick, or other suitable material, and having a grating, *c'*, extending across its lower part, and constituting part of the upper portion of an arched passage (H, I, K, or L), arranged underneath such chamber. Upon this grating is a pile, *d*, of fire-bricks, or other heat-absorbing and indestructible materials, the same being arranged or stacked in such manner as to leave interstices or spaces between them, so as to en-
able the air or gas, while passing through the pile, to come in
213 contact with the surfaces of the several parts or bricks thereof. Each of the said regenerators is arched or closed over at its

top, and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or *f'*, as shown in the drawings. The two passages *f f'* lead out of the furnace A in opposite directions, and from opposite ends thereof.

Directly underneath the bed of the furnace A, and between it and the tops of the two inner regenerators B^2 and B^3, there is an air chamber or space, C, which should communicate freely at its opposite sides or ends with the atmosphere, in order that a current of cool air may be caused to continually pass through it, for the purpose of maintaining the bed of the furnace, as well as the arches of the regenerators B^2 B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators while they may be in operation.

In rear of the upper parts of the regenerators and below the furnace there is an air space or chamber, D, which at intervals is bridged, as shown at *g g g*. There is also below the space D a sunken space or chamber, E, in which are situated the levers for working the dampers of the apparatus. In front of the space E there is a passage, F (see figure 6), which continues horizontally in opposite directions, and thence drops downward, and at its two extremities opens respectively into the two passages H and L, which extend underneath the two outermost regenerators. Each of these passages H I K L is to be closed at both of its ends, but the two middle passages I K are shown in figure 4 as open at their rear ends. These middle passages, however, with vertical continuations of them leading into a horizontal passage, N, are, as well as the said passage N, to be walled up or covered in rear. The same may be said with respect to a gas tube or passage, O', which is to lead from the generator and into the passage N, as is shown in figures 3 and 4.

Between the two passages I K there is a smoke flue, P, into the rear part of which there is an opening, Q', leading from the passage F, or a damper case, R, arranged vertically therein, and having a damper, S, arranged within it, and so as to be capable of being turned by a lever, *h*.

There is another such damper case, T', applied in the passage N, and opening at its opposite sides into such passage,
214 and also at its top into the generator conduit or gas flue O'.

Within the case F there is a damper U, capable of being turned by a lever, *i*. Situated over each of the damper cases there is a valve opening, V' or W', provided with a valve, X or Y, the whole being arranged as shown in figures 3 and 4.

By means of the damper U gas from the passage O' may be led into either of the passages I K, it being cut off from passing into one while it may be passing into the other So, by means of the damper S, air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other. The valve Y will serve to arrest the flowage of air into the passage F. So, with the valve X it will answer to close off the passage of gas into the damper case immediately underneath it.

The operation of the said apparatus having been hereinbefore sub-

stantially described, we now proceed to point out what we claim as our invention; that is to say:

We claim, in combination with a furnace (A), and its chimney or smoke-discharge flue (P), a system or series of air and gas regenerators (B^1 B^2 B^3 B^4), constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace and out of the chimney, in manner and so as to be operated as and for the purpose or purposes hereinbefore described.

We also claim the arrangement and combination of the air space or open chamber C with the furnace and its system of regenerators, arranged and applied together, substantially in manner and so as to operate as described.

We also claim the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified.

CHARLES WILLIAM SIEMENS.
FREDERICK SIEMENS.

Witnesses:
ROBERT SINKSON,
G. A. BRYANT,
Both of No. 2 Pope's-Head Alley, London, Gentlemen.

215 CONSULATE OF THE UNITED STATES OF AMERICA AT LONDON:

I, Freeman H. Morse, consul of the United States of America for London and the dependencies thereof, do hereby make known and certify to all whom it may concern that William Webb Venn, who hath signed the annexed certificate, is a notary public, duly admitted and sworn, and practising in the city of London aforesaid, and that to all acts by him so done full faith and credit are, and ought to be, given in judicature and thereout.

In testimony whereof I have hereunto set my hand and affixed the seal of the consulate of the United States, at London aforesaid, this eleventh day of August, in the year of Lord one thousand eight hundred and sixty-three, and in the eighty-eighth year of the Independence of the said United States.

[SEAL.] F. H. MORSE.

I, William Webb Venn, of London, notary public, duly admitted and sworn, do hereby certify that, W. W. V., N. P., on this eleventh day of August, A. D. 1863, W. W. V., N. P., personally appeared before me the above or within named Charles William Siemens and Frederick Siemens, and made solemn oath that they verily believe themselves to be the original and first inventors of the hereinbefore described invention, having reference to furnaces of various kinds, for which they solicit a patent of the Government of the United States of America; that they do not know or believe that the same was ever known or used before their invention thereof; and that they are subjects of the, W. W. V., N. P., undermentioned authorities, viz., the said Charles William Siemens being a naturalized subject

of the Queen of Great Britain, and the said Frederick Siemens being a subject of the Grand Duke of Mecklenburg-Strelitz, in Germany.

In testimony whereof I have hereunto set my notarial firm and seal of office to serve and avail where needful, and the said two above-named deponents have also signed with me, notary, in cor-
216 roborate of the truth of their foregoing affidavit.

London, *datum ut supra.*

CHARLES WILLIAM SIEMENS.
FREDERICK SIEMENS.

In fidem.

[SEAL.] WILLIAM W. VENN,
Notary Public.

To the Commissioner of Patents of the United States of America:

The petition of Chas. Wm. Siemens & Frederick Siemens, of Westminster, in the Kingdom of Great Britain, respectfully represents:

That your petitions have invented a new and useful invention, having reference to furnaces of various kinds, which they verily believe has not been known or discovered by any other person or persons prior to their invention thereof.

Your petitioners therefore desire that letters patent may be granted to them securing to them and their legal representatives for the term of seventeen years an exclusive property in the above-mentioned invention, or right to make and use it, and to vend it to others, by them to be made, used, or sold, as it is described in the accompanying and written specification; your petitioner, Charles William Siemens being a naturalized subject of the Queen of Great Britain, and your other petitioner, Frederick Siemens, being a subject of the Grand Duke of Mecklenburg-Strelitz, in Germany, and having paid fifteen dollars into the Treasury of the United States, and complied with all the other conditions expressed in the acts of Congress for such cases made and provided.

Signed at London, the eleventh day of August, in the year of our Lord eighteen hundred and sixty-three.

CHARLES WILLIAM SIEMENS.
FREDERICK SIEMENS.

CONSULATE OF THE UNITED STATES OF AMERICA AT LONDON:

I, Freeman H. Morse, consul of the United States of America for London and the dependencies thereof, do hereby make
217 known and certify to all whom it may concern that William Webb Venn, who hath signed the annexed certificate, is a notary public duly admitted and sworn and practising in the city of London aforesaid, and that to all acts by him so done full faith and credit are and ought to be given in judicature and thereout.

In testimony whereof I have hereunto set my hand and affixed the seal of the consulate of the United States, at London aforesaid, this eleventh day of August, in the year of our Lord one thousand

eight hundred and sixty-three, and in the eighty-eighth year of the Independence of the said United States.

[SEAL.] F. H. MORSE.

To the Commissioner of Patents of the United States of America.

SIR: Having invented a new and useful invention having reference to furnaces of various kinds and made application for letters patent of the United States of America therefor, we hereby appoint, and request you will recognize, R. H. Eddy, civil engineer, of Boston, in the State of Massachusetts, to be our true, sufficient, and lawful attorney and agent, for us and in our name, to attend to procuring and receiving the said letters patent, and to alter and amend our specifications, drawings, and claims previous to the said letters patent being granted in whatever way, manner, and extent he, the said Eddy, may consider most desirable for our interest, and to execute and deliver any papers, and, generally, to do and perform all such acts, matters, and things as may be necessary for the complete and effectual obtaining of the said letters patent, or for the withdrawal of the application of the same, or any papers, drawings, or models connected therewith should he at any time deem such withdrawal advisable. In case of such withdrawal of the said application the Commissioner of Patents or the Treasurer of the United States is hereby authorized to pay to the said Eddy for us, and the said Eddy is empowered to receive for us, such sum of money as the law provides shall be returnable under such circumstances to any applicant for a patent.

1 dollar 1 C. W. S., F. S., Aug. 11, 1863.

1 dollar 1

218

Signed at London the eleventh day of August, A. D. 1863.

CHARLES WILLIAM SIEMENS.
FREDERICK SIEMENS.

Witnesses:
ROBT. SINKSON.
G. A. BRYANT.
Both of No. 2 Pope's-Head Alley, London, Gentlemen.

I, William Webb Venn, of the city of London, notary public by royal authority, duly admitted and sworn, certify that on this eleventh day of August, A. D. 1863, personally appeared before me the above-named Chas. Wm. Siemens & Frederick Siemens and acknowledged the above instrument to be their free act and deed.

In testimony whereof I have hereunto set my notarial firm and seal of office to serve and avail where needful.

London, *datum ut supra.*
In fidem.

[SEAL.] WILLIAM W. VENN,
Notary Public.

BOSTON, *Dec.* 2, 1863.

SIR: Herewith I send you a Treas. cert. of $20 as balance of patent fee due on C. W. & Fred'c. Siemens' imp't in furnaces.

Yours, resp'y,

R. H. EDDY.
P'r F. P. HALE, JR.

Hon. D. P. Holloway, Com'r Patents, Washington, D. C.

219 BOSTON, *Dec.* 2, 1863.

Hon. D. P. Holloway, Com'r Patents, Washington, D. C.

SIR: I have to-day forwarded you a Treas. cert. of $20, as balance of fee due on Messrs. C. W. & Fred'c. Siemens' application for a patent for an improvement in furnaces. I have to request that the patent may not be issued until you receive further orders from me, as the Messrs. Siemens have assigned all their interest in the said invention to parties in this country, and such parties are desirous of having the patent issued directly to them.

The assignment is duly excepted from Europe, and as soon as received I will forward the same to you. The $20 is merely paid to prevent the loss of the patent through default of payment of the fee prescribed by law.

Yours, resp'y,

R. H. EDDY,
P'r F. P. HALE, JR.

BOSTON, *Dec.* 9, 1863.

SIR: The official letter of the 7th inst., in reply to mine of the 2nd, relative to the issuing of the patent of Messrs. C. W. & F. Siemens, has been received, and has surprised me very much, for I cannot conceive how my letter was received too late to prevent compliance with the request therein contained, for the cert. of deposit of the sum of $20 was sent with the letter in the same mail, and there does not appear to be any good reason why the office should enter for record the patent to issue on the 15th "proximo." I beg the Commissioner to stay the matter, in accordance with the request, as any other action will seriously endanger or endamage the interests of certain parties who have been the means of importing the invention into this country. In due time the Commissioner will be advised when it is desirable to have the patent issue.

Yours, respectfully,

R. H. EDDY,
P'r F. P. HALE, JR.

Hon. D. P. Holloway, Com. Patents, Washington, D. C.

220 BOSTON, *Feb.* 16, 1864.

SIR: I have to request the favor of you to order the issue of Messrs. Charles William and Frederick Siemens' patent for a new and useful improvement in furnaces.

Yours, resp'y,

R. H. EDDY,
P'r F. P. HALE, JR.

Hon. D. P. Holloway, Com. Patents, Washington, D. C.

2039.

No. 41,788.
Chas., Wm. and Frederick Siemens,
Of London,
County of ——
Kingdom of Great Britain.

Furnaces.

Rec'd, September 23rd, 1863.
Petition, " " "
Affidavit, " " "
Specification, " " "
2 Drawings, " " "
Model, " " "
1 Cert. dep., $15, " " "
Cash,
Add'l fee cert. $20, Decr. 4, '63.
" " cash,
Examined, B. S. Hedrick, Sept. 30, '63.
2 Issue Hayes, Octo. 1, 1863.
3 Patented Mch. 1, 1864.
Recorded, vol. 159, page 67.
Circular, Oct. 2, 1863.

R. H. EDDY,
Boston, Mass.

Ex'd: E. A. M. F. H. M. H.

221 (Coat-of-arms of Great Britain.)

A. D. 1861, 22nd January. No. 167.

Specification of Charles William Siemens and Frederick Siemens' Furnaces.

222 DEFENDANTS' EXHIBIT COMPLAINANTS' ENGLISH PATENT OF 1861. C. F. Z., Sp. Ex., March 29, 1882.

(Coat-of-arms of Great Britain.)

A. D. 1856, 22nd January. No. 167.

Furnaces.

Letters patent to CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS, both of Great George street, Westminster, for the invention of "improvements in furnaces."

Sealed the 19th July, 1861, and dated the 22nd January, 1861.

Provisional Specification left by the said Charles William Siemens and Frederick Siemens at the Office of the Commissioner of Patents with their Petition on the 22nd January, 1861.

We, Charles William Siemens and Frederick Siemens, both of Great George street, Westminster, do hereby declare the nature of

the said invention for "improvements in furnaces" to be as follows:

These improvements relate to that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion, and to communicate the same subsequently to the air supporting combustion.

In constructing furnaces for melting glass, or for other pur-
223 poses where a chamber is to be heated to a high degree, we place four regenerators below the level of the bed of the furnaces, and when we place the regenerators immediately underneath the furnace we form a space for the circulation of cold air between the arches, covering the regenerator and the under side of the bed of the furnace.

Passages lead from the upper extremity of two of these regenerators into the furnace or chamber to be heated at one point or extremity, while similar passages lead from the two remaining regenerators, and communicate with the heated chamber at another point, the passages uniting upon entering or shortly before entering the furnace. The lower extremities of the four regenerators communicate with valves or reversing dampers, by means of which currents of air and the combustible gas which we employ are directed through the whole system of regenerators and furnace in the following manner: A current of atmospheric air enters through one of the valves with one of the four regenerators at the bottom, while a current of gas is directed into a second regenerator. The two currents ascend through the masses of loosely-piled brick work, or other refractory material of which the regenerators are composed, and unite on entering the heated chamber or furnace where they are fired. After having traversed the furnace the products of combustion pass downwards through the two remaining regenerators, imparting heat to the same, and are thence directed into a chimney. When the two last-named regenerators have been heated sufficiently the direction of the currents is reversed. Currents of air and gas are made to enter these two regenerators separately, and are heated in ascending through them; and when these heated currents unite at the point of entrance into the furnace they produce an intensely hot flame. We arch over the regenerators in such a manner that the gases unite only near the point where they enter the furnace, at which place they rise up between perpendicular walls. These passages are so arranged that any fluid or impurity that may fall from the furnace down them will not enter the regenerator at all, but will be
received by small chambers or pockets provided for that pur-
224 pose; proper openings or doors are provided by which these pockets may be emptied from time to time as occasion may require.

It is an essential part of our invention that the solid fuel should be decomposed in a separate apparatus (which we shall hereafter describe), so that the introduction of solid fuel into the furnace may be altogether avoided; and independently of the advantage that results from heating the gaseous fuel prior to its entering into combustion, there is a great advantage derived from the absence of any

solid carbon or ashes in the working chamber of the furnace, by which we are enabled to carry on operations in the open furnace which it has only been possible hitherto to conduct in covered vessels or pots. We are thus enabled to melt flint and other superior qualities of glass in open pots to fire pottery without enclosing the same in saggers, or to melt steel and other substances upon an open hearth or bed without injury. Dampers are provided in the cold air and gas channels, by which the quantity and quality of the flame can be regulated to the utmost nicety.

In applying our improvements to glass furnaces we find it sometimes advantageous to melt the materials composing the same in open pots, but to cover them with moveable lids whilst working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces, for instance, to heat annealing furnaces or lears in the manufacture of glass, we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated where they join in combustion. Dampers of fire clay or other refractory material are provided to these channels to regulate the flow of the gases according to the direction in which the main furnace is working. In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide two similar furnaces side by side, and only one set of four regenerators, which by means of slides or valves of fire-clay or other refractory material, can be made to communicate at intervals with the one furnace or heated chamber or the other. During the time that one furnace is fired the other is allowed to cool, to be discharged and charged again with fresh material, and *vice versa*. The regenerators are thus always kept in working condition.

Another part of our improvements consists in the arrangement of the gas generators. It is important that the combustible gases produced from the heat should be as rich as possible in hydrogen, carburetted hydrogens, and carbonic oxide, with as little admixture of carbonic acid, nitrogen, and incombustible vapours as may be.

The apparatus should be so arranged as to be very regular in its action, and be easily tended and freed from cinders from time to time. It is also important that the gas produced is not drawn through the furnace by the chimney, but that the full atmospheric pressure is maintained in the channels leading from the gas generator to the furnace, lest atmospheric air should be drawn in through crevices and produce a partial combustion of the gas in the channels, which might be accompanied by a deposition of carbon in the same.

The arrangements we adopt are as follows: The fuel is fed through openings fitted with lids or covers into a hopper, which we place by preference at a moderate inclination. From the hopper the fuel passes down an inclined plane formed of brick-work at an

angle of 45 degrees or thereabouts, and thence upon a grate, which may advantageously be inclined 30 degrees or thereabouts to the horizon. Directly opposite the inclined plane and grate, but at a sufficient height to allow of a thick layer of fuel on the bars, is a brick arch, parallel to it or nearly so, which, being once heated by the combustion upon the grate, radiates heat down upon the fresh fuel as it gradually passes down the inclined plane, and thus causes its partial decomposition and volatilization, which is afterwards completed by the fresh air entering through the grate. The air, in passing through the carbonaceous part of the fuel, produces in the first instance carbonic acid gas, accompanied by intense heat, and then, as
226 this carbonic acid gas ascends through the mass of incandescent carbon, it is converted into carbonic oxide of a somewhat lower temperature, and this carbonic oxide, accompanied by its necessary proportion of nitrogen, is directed by the arch over the surface of the fresh fuel upon the inclined plane, and thus helps to volatilize the fuel. The combined gases are allowed to ascend through a tube, which being exposed to the atmosphere causes the gases to become somewhat cooled before they descend again to the valve by which they are admitted to the regenerator; the preponderance of the cool descending column over the ascending hot column of gas causes sufficient draught to produce a plenum of pressure in the channels leading to the regenerator. If several generators are provided we prefer to lead the gases produced by them into a main channel, which may be arranged to supply several furnaces, the advantage of this arrangement being that a greater uniformity in quantity and quality of the gas [is] obtained.

Specification in pursuance of the conditions of the Letters Patent filed by the said Charles William Siemens and Frederick Siemens in the Great Seal Patent Office on the 32*nd July*, 1861.

To all to whom these presents shall come, we, Charles William Siemens and Frederick Siemens, both of Great George street, Westminster, send greeting:

Whereas her most excellent majesty Queen Victoria, by her letters patent, bearing date the twenty-second day of January, in the year of our Lord one thousand eight hundred and sixty-one, in the twenty-fourth year of her reign, did, for herself, her heirs and successors, give and grant unto us, the said Charles William Siemens and Frederick Siemens, her special license that we, the said Charles William Siemens and Frederick Siemens, our executors, administrators, and assigns,
227 or such others as we, the said Charles William Siemens and Frederick Siemens, our executors, administrators, and assigns, should at any time agree with, and no others, from time to time, and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an invention for "improved arrangement of furnaces," upon the condition (amongst others) that we, the said Charles Wil-

liam Siemens and Frederick Siemens, our executors or administrators, by an instrument in writing under our or their hands and seals, or under the hand and seal of one of us or them, should particularly describe and ascertain the nature of the said invention, and in what manner the same was to be performed, and cause the same to be filed in the great seal patent office within six calendar months next and immediately after the date of the said letters patent.

Now know ye, that I, the said Charles William Siemens, on behalf of myself and the said Frederick Siemens, do hereby declare the nature of the said invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof; that is to say:

These improvements relate to that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion, and to communicate the same subsequently to the air supporting combustion. It is an essential part of our invention that the solid fuel used, such as coal, lignite, peat, &c., should be decomposed in a separate apparatus, so that the introduction of solid fuel into the furnace may be altogether avoided, and the gaseous fuel may be heated to a high degreee prior to its entering into combustion with atmospheric air, also heated to a high degree, thus causing a great economy of fuel. There is also a great advantage derived from the absence of any solid carbon or ashes in the working chamber of the furnace by which we are enabled to carry on operations in the open furnace, which it has only been possible hitherto to conduct in covered vessels or pots. We are thus enabled to melt flint, extra white, 228 and other superior qualities of glass in open pots, to fire pottery without enclosing the same in saggers, or to melt steel and other substances upon an open hearth or bed without injury. It is also important in many operations that the state of pressure of the gases in the furnace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmospere, in order to prevent the egress of flame from, or the ingress of atmospheric air into, the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass, puddling iron, &c. For this purpose we arrange four regenerators below the bed of the furnace, two of which serve to communicate heat separately to the combustible gases and atmospheric air on their way to the furnace, and the remaining two to absorb the waste heat from the products of combustion passing through them indiscriminately before reaching the chimney (their respective action being reversed at intervals), the currents of heated gas and air in ascending through and from the regenerators into the furnace causing a plenum of pressure within the same, which is capable of being modified or regulated by valves for the admission of the gas and air to the regenerators and by the chimney damper. By the same arrangements the chemical qualities as well as the intensity of the flame can be regulated to the utmost nicety. In some cases, where no great heat is required, or where the gas used is very rich in com-

bustible matter, the two regenerators intended for heating the combustible gasses may be suppressed and mere passages be substituted, but we generally prefer the four-regenerator arrangement. In order to prevent an accumulation of excessive heat in the arch covering the regenerators, and forming at the same time the support of the furnace bed, we provide chambers between the same for the circulation of atmospheric air. Glass, slag, or other matters that may flow from the bed of the furnace are made to drop into pockets or chambers on the side of the regenerators, whence they can be readily removed.

In applying our improvements to glass furnaces we find it sometimes advantageous to melt the materials composing the
229 same in open pots, but to cover them with movable lids whilst working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces, for instance, to heat annealing furnaces or lears in the manufacture of glass, we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated where they join in combustion. Dampers of fire clay or other refractory material are provided in that case to these channels to regulate the flow of the gases according to the direction in which the main furnace is working; or we draw off the mixed gases in a state of combustion from the principal furnace. In firing pottery ware, in calcinting ores, and other operations, it is required that the furnace charged with these materials, after having being heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces side by side and only one set of four regenerators, which, by means of slides or valves of fire clay or other refractory material, can be made to communicate at intervals with the one furnace or heated chamber or the other. During the time that one furnace is fired the other is allowed to cool, to be discharged and charged again with fresh material, and *vice versa*. The regenerators are thus always kept in working condition. Or we arrange four or more chambers in such a way that they themselves are made to contain the materials to be fired, serving alternately as regenerators and as kilns, to be fired or discharged.

Another part of our improvements consists in the particular arrangements of gas generators. It is important that the combustible gases produced from the fuel should be as rich as possible in hydrogen, carburetted hydrogen, and carbonic oxide with as little admixture of carbonic acid, nitrogen, and incombustible vapours as may be. The apparatus should be so arranged as to be very regular in its action, and be easily tended and freed from cinders from time to time It is also important that the gas produced is not drawn through the furnace by the chimney, but that the full atmospheric pressure is maintained
230 in the channels leading from the gas generator to the furnace, less atmospheric air should be drawn in through crevices, and produce a partial combustion of the gas in the channels, which

might be accompanied by a deposition of carbon in the same. This we accomplish in allowing the hot gases to ascend from the generators and to descend again after they have been partially cooled by exposure of the pipes containing them to the atmosphere. The decomposition of carbon is, moreover, avoided by the introduction into the generators, or channels leading from the same, of streamlets of water or of steam, which, in combining with the heated portions of solid carbon, form permanent combustible gases with the same, namely, carbonic oxide and hydrogen. If several generators are provided, we prefer to lead the gases produced by them into a main channel, which may be arranged to supply several furnaces, the advantage of this arrangement being that a greater uniformity in quantity and quality of the gas is obtained.

But in order that our invention may be more easily understood and readily carried into effect, we will now describe the best means are acquainted with of performing the same, reference being had to the accompanying drawnings.

Figures 1, 2, 3, 4, and 5, on sheet I, represent one arrangement of our improved regenerative gas furnace as applied to the manufacture of glass, together with the generator for the combustible gases employed therein. Figure 1 is a longitudinal section through the furnace and regenerators; figure 2 is a sectional plan; figure 3 is a transverse section through the furnace, regenerators, and gas generators; figure 4 is a section through the passages leading from the regenerators to the gas generators, chimney, and atmosphere, and also shews the furnace in elevation; figure 5 shews a longitudinal section through one of the gas generators. Similar letters indicate similar parts in all the figures.

A is the furnace, upon the bed *a* of which stands the glass pots X X X, apertures *b b b* being provided for working out the glass.

231 Beneath the bed of the furnace are the four regenerators, B^1 B^2 B^3 B^4, each consisting of a chamber built of fire brick, near the bottom of which is a grating, c^1, c^2, c^3, c^4; upon this grating are piled the fire bricks or other refractory material d^1 d^2 d^3 d^4 in such a manner as to leave small interstices between each brick. These regenerators are arched over at the top, and support the bed *a* of the furnace. This consists of a number of slabs of fire-clay or other refractory material, having on their under side small channels *e e e*, communicating at one end through the channel *f* with the atmosphere, and at the other end with the air passage I, conducting to the regenerators. A current of cold air is continually passing through these channels, tending to maintain the bed of the furnace and the arches covering the regenerators at a low temperature. Communications are established between the top of the four regenerators B^1 B^2 B^3 B^4 and the furnace A in the following manner: The regenerator B^1 communicates with the furnace at the point C, through the passages D^1 D^1 D^1, while the regenerator B^2 communicates with the furnace at the same point C, through the passages D^2 D^2. In a similar manner the regenerator B^3 communicates at the point C^1 with the furnace through the passages D^3 D^3, whilst the regenerator B^4 communicates with the furnace at the same point C^1 through the

passages D^4 D^4 D^4. At these points C and C^1, the passages D^1 and D^2, as also those D^3 and D^4, are separated from each other by the vertical division walls i i^1, till they reach the level of the bed of the furnace. It will be seen that any glass or other materials falling through the apertures D^1 D^2 D^3 D^4 from the bed of the furnace will not enter the regenerators, but will fall into the chambers or pockets E E^1 at the side of the same, whence they can be removed through the apertures l l^1, ordinarily kept closed.

Each of the regenerators B^1 B^2 B^3 B^4 are provided below the gratings c^1 c^2 c^3 c^4 with openings F^1 F^2 F^3 F^4; by means of these the generators B^1 and B^4 communicate alternately with the passage G leading from the gas generators which will be hereafter described, and with the passage H leading to the chimney, whilst the regenerators B^2 and B^3 communicate alternately with the passage I,
232 communicating with the atmosphere, and the passage H leading to the chimney. These alternate communications are regulated by the reversing valves or dampers g and h in the following manner: If the valve g is in the position indicated in figure 4, then combustible gas from the generator will pass through the passages J J, and will enter the regenerator B^4 through the aperture F^4; if at the same time the valve h is in the same position as g, then atmospheric air will enter from the passage I into the generator B^3, through the passage L and aperature F^3. If the regenerators B^3 and B^4 have been previously heated by the hot products of combustion passing through them, then the currents of air and combustible gas in passing up through the small interstices between the bricks will become heated to a considerable degree. Arrived at the top of the regenerators, they will be conducted through the passages D^3 and D^4 to the point C^1 of the furnace, where on rising up between the vertical division walls i^1 i^1, they will unite, and on being ignited evolve an intensely hot flame, which passes across the furnace and imparts its heat to the glass pots X X X. Arrived at the other end of the furnace the hot products of this combustion pass downwards through the passages D^1 and D^2, into the regenerators B^1 and B^2; here, on passing downwards through the mass of loosely-piled bricks, these latter absorb the greater part of the heat of the gases, and they issue in a comparatively cold state through the apertures F^1 and F^2 into the passages K K and M, whence the reversing valves g and h being in the position indicated, they are conducted through the flue H H to the chimney shaft. When by the continued passage of the hot products of combustion the regenerators B^1 and B^2 have become heated to a considerable degree, the position of the valves or dampers g and h are reversed by means of the levers Z Z; combustible gas will now enter into the regenerator B^1 and atmospheric air into the regenerator B^2; these currents of gas and air on passing up through the regenerators will become heated to a considerable degree, and on emerging from them at the point C will mix, will become ignited,
233 and the hot products of combustion, after traversing across the furnace, will pass down at C^1, through the regenerators B^3 and B^4, imparting to these the greater part of their heat, and thus each pair of regenerators will alternately serve to absorb

the heat from the products of combustion, and then give off this same heat again to the gas and air serving to produce this combustion. A passage, Y, is provided at the side of the regenerators for obtaining access to them through the openings y^1 y^2 y^3 y^4.

The combustible gases are produced in a series of gas generators N, N, by the imperfect combustion of fuel. In these gas generators the fuel is introduced through the hoppers O, kept closed by means of the covers *o*, *o*; from these hoppers the fuel descends on to an inclined plane P of fire-brick or other refractory material, which may be inclined about 45 degrees; thence the fuel passes on to the fire-grate Q, which should be inclined about 30 degrees. Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, is an arch of fire-brick R. This arch, being once heated to a considerable degree by the fire on the grate, radiates heat on to the fresh combustibles as they pass down the inclined plane P, and thus causes their partial decomposition and volatilization, which is afterwards completed by the atmospheric air which enters through the grate Q. This air, on passing through the layer of highly heated fuel lying upon the grate, is first decomposed into carbonic acid gas with a certain proportion of nitrogen, and afterwards, on passing up through the thick layer of fuel in a less state of incandescence, it becomes transformed into carbonic oxide, and in this form passes over the surface of the fresh fuel on the inclined plance P, where it mixes with the gases evolved from the same, and then passes up through the passage S into the vertical pipe T, and from this into the horizontal pipe U, which establishes a communication between all the gas generators and the regenerators B^1 and B^4. This pipe descends again at U^1, where it joins on to the flue G, by which means the column of gas in the pipe U^1 being somewhat cooler, and consequently more dense than the column of gas in the pipe S, a sufficient draft is maintained without the gases in the flue G having to be drawn through
234 by the action of the chimney, and thus a plenum of pressure is maintained in these passages so as effectually to prevent atmospheric air entering into them through fissures, and causing a partial combustion of the gases.

An aperture, V, is formed in the top of the generator for the purpose of stirring the fuel from time to time. Valves *w* are provided in the pipes T of each gas generator so as to shut off the communication with any one of them when not in use or under repair. A small water supply pipe, *k*, is provided with little branches and taps for admitting a small driblet of water into the gas generator through the funnel *l* on the pipe T; this small current of water passing along the side of the pipe, and falling partially on the body of the fuel, becomes vapourized, and the vapour thus formed, acting upon any hot particles of carbon rising up with the gases, combines with the same, forming two combustible gases, namely, carbonic oxide and hydrogen.

The gas generator just described is particularly adapted for dry coal. In figures 6 and 7 is shown an arrangement of the same which we prefer employing where very gaseous or "baking" coal is used.

The general construction is in most respects similar to the just described one. A A are hoppers through which the fuel is introduced; B B are the inclined planes of fire brick over which the fuel passes, whence it falls onto the table C. In place of the ordinary fire grates we here employ two iron plates, D D, with perforations, and provide two bars, E E, beneath these with apertures for the means of breaking up the coal when it becomes caked. Apertures F F are also provided for stirring up the coal from the top. The heated arch G serves to volatilize the fresh fuel partially as it descends from the hoppers; H is the ascending flue through which the gases are conducted to the regenerators. Streamlets of water may be introduced through H, or elsewhere, which are not shown on the drawing. The passage H is sometimes continued down into the body of the fuel, as shown in dotted lines, so that the combustible gas has to pass through the fuel before entering the same, and is thus deprived of particles of tar, &c.

235 Figures 8 and 9 shew an arrangement of our improved regenerative gas furnace as applied to the manufacture of glass, where the furnace is of a circular shape, and is also connected with a lear for annealing purposes. Figure 8 shows a sectional elevation of the furnace and lear, and figure 9 shows a sectional plan of the furnace and regenerators. The furnaces A itself is here of an annular shape; the central space B communicates by the apertures *a a* with the furnace, and is provided at the top with a flue, *b*, through which it communicates with the lear C, constructed immediately over the furnace. This is closed at either end by doors, or in any other temporary manner, and is provided at one end with the chimney shaft D, having a damper, *c*. Beneath the bed *f* of the furnace, which is provided with channels *e, e*, for the circulation of cold air, are the four regenerators E^1, E^2, E^3, E^4 constructed in a similar manner to those described with reference to figures 1, 2, 3, and 4. These communicate with the furnace at F, F^1, through the passages G^1, G^2, G^3, G^4, and are connected below with the passages from the gas generators, the atmosphere, and the chimney, which are not shown in the drawing. Reversing valves or dampers, also omitted on the drawing, cause the combustible gas and air to flow through one pair of regenerators, and then cause the products of their combustion, after traversing the furnace A and heating the glass pots X, X, X, to pass down through the other pair of regenerators in a precisely similar manner to the regenerators described in figures 1, 2, 3, and 4.

When it is required to anneal objects of glass in the lear C whilst the furnace is at work, the damper *c* in the chimney D is opened, in consequence of which a portion of the gases in a state of combustion pass from the furnace A into the chamber B, and thence through the flue *b* into the lear C, where they heat the objects placed in the trays *d, d, d* to the required extent in that portion of the lear immediately over the furnace, and then escape up the chimney D. The trays *d d* containing the articles, in being passed gradually along towards the chimney, are removed gradually from the hotter
236 to the cooler portion of the lear, as is well understood. When the lear is not in operation the damper *c* in the chimney D

is closed, and the hot products of combustion are thus prevented from escaping from the furnace into the lear.

In our improved regenerative gas furnaces for glass we sometimes dispense with the use of pots altogether, and place the materials to be melted on the bed of the furnace itself, which is then made of a certain depth.

In figure 10, sheet II, of the accompanying drawings is shown such an arrangement. The bed of the furnace A consists of the two sloping sides B B and the central channel C. Upon the highest part of the sloping sides B B are heaped the materials *a a*, to be melted. The heated currents of combustible gas and air passing into the furnace from the generators D, through the passages E, in a similar manner to that already described with reference to figures 1, 2, 3, and 4 on sheet I, are ignited in the furnace, and the intense heat thus produced melts the heaped-up materials *a a*, and the melted glass running down in a thin sheet from these heaps over the highly-heated surfaces B B of the bed planes at once, and is in this state collected in the channel C, whence it may be worked out immediately, instead of having to wait several hours before the glass planes, as is the case where it is melted in pots. The hot products of combustion pass down through the passages E^1 into the other pair of regenerators D^1, in the same manner as has already been described. Channels *e e f f* are formed in the bed of the furnace, through which cold air circulates to moderate the temperature of the same. This arrangement of furnace may also be employed with advantage for smelting iron, for making steel, or roasting copper and other ores.

In figures 11, 12, and 13 is shown a construction of our improved regenerative gas furnace adapted for the purpose of puddling iron.

Figure 11 shows a longitudinal section through the same; figure 12 shows a sectional plan above the bed of the furnace; and figure 13 shows a sectional plan of the regenerators.

The bed A of the furnace B is made of a considerable
237 depth, and is constructed of iron covered with fire-brick or other refractory material. Below the bed spaces, *a a a*, are provided for the circulation of cold air. Beneath the furnace are the regenerators C^1, C^2, C^3, C^4, constructed in a similar manner to those already described. By means of the reversing valves or dampers D E, actuated by the levers *d*, *e*, the regenerators C^1 and C^3 are made to communicate alternately with the gas generators through the passages F and G, and with the flue Z leading to the chimney, whilst the regenerators C^2 and C^4 are made to communicate alternately with the atmosphere through the passages H and I, and with the chimney through the flue Z. Thus if gas is entering at the bottom of the regenerator C^3, and atmospheric air is entering at the bottom of the regenerator C^4, they become heated on passing through the masses of loosely-piled bricks; arrived at the top they pass up through the passages J and K, and into the furnace through the side openings J^1, K^1; here they unite, and on being ignited heat the furnace to the required extent, the hot products of combustion traversing across the furnace and then passing through the side openings

L^1, M^1, into the passages L M, and then down into the two regenerators C^1 and C^2 in the manner as already hereinbefore described with reference to other arrangements. The apertures J^1, K^1, L^1, and M^1, leading from the regenerators into the furnace, are here with advantage constructed in the side of the same instead of in the bed, as in the before-described arrangements. This allows of channels N and O being formed between them, leading from the bridges *b b* down to the small openings *c c*, through which cinders and other impurities are removed from the furnace. A door X is provided as usual in the side of the furnace for working the iron.

In figures 14, 15, 16, and 17, on sheet II., is shewn the application of the principle of our regenerative gas furnace to the burning of bricks or other objects in kilns; figure 14 shews a longitudinal section through four such kilns in connection; figure 15 shews a sectional plan of the same, as also a plan of the gas generator connected thereto; figure 16 shews a transverse section; and figure 17 shews a section through the gas generator.

238 In this arrangement the bricks or other objects to be burnt or fired are piled up loosely in the kilns and themselves form the regenerators, which alternately absorb the heat from the products of combustion resulting from the burning of gas and air in one of the charged kilns, and then after being themselves fired give off their heat again to the air serving for the combustion of gases in another kiln.

The four kilns A^1, A^2, A^3, A^4, are for this purpose connected with each other, with the gas generator, with the chimney, and with the atmosphere in the following manner: The bottom of the kiln A^1 communicates with the top of the kiln A^2 through the passage a^1, the bottom of A^2 communicates with the top of A^3 through the passage a^2; the bottom of A^3 communicates with the top of A^4 through the passage a^3, and the bottom of A^4 communicates with the top of A^1, through the passages X and a^4. Slides c^1, c^2, c^3, c^4, for dampers are provided in each of the passages a^1, a^2, a^3, a^4, but there is only one damper to all the four passages, which is consecutively placed in each, as shall be hereafter explained. An underground flue B passes from the gas generator C, which is also below the level of the ground along the front of all four kilns, in front of each of which it opens into vertical shafts D^1, D^2, D^3, D^4, which are closed at the top and from which branch the pipes E^1, E^2, E^3, E^4; these pipes enter into the centre of the side of each kiln, and branches e^1, e^2, e^3, e^4, on the same also enter into the before-mentioned passages a^1, a^2, a^3, a^4. All these branches are provided with valves actuated by levers b^1, b^2, b^3, b^4, by means of which the gas can either be admitted through the passages a^1 a^2 a^3 a^4 into the top of the kiln or through the branches E^1 E^2 E^3 E^4 into the middle of the kiln, or the gas can be shut off from the kilns altogether. When the kilns are charged with bricks or other objects to be burnt, a tube F^1, F^2, F^3, F^4, having perforations, is placed in the same in such a position that the gas when entering the kiln through the pipes E^1 E^2 E^3 E^4 passes into these tubes, thus being more equally distributed throughout the mass; or, in place of having tubes, such passages may be formed with the bricks themselves. Rows

of bricks are left out here and there at the level of these tubes so as to allow of the easy egress of the gas from them. Each of the kilns is furthermore provided with an aperture, G^1 G^2 G^3 G^4 at the bottom, connecting them by means of branches to the flue H conducting to the chimney shaft; each of the openings are capable of being closed by means of dampers g^1 g^2 g^3 g^4.

Large openings, I^1 I^2 I^3 I^4 are provided at the top of each kiln for the purpose of charging and discharging them; these are temporarily bricked up when the kiln is at work, but the one being open where the kiln is being charged serves to admit the atmospheric air that has to assist the combustion of the gas in the kiln that is being fired. If we now suppose that the contents of the kiln A^1 are being fired; that the contents of the kiln A^2 have been freshly filled in, and are being heated preparatory to firing; that the kiln A^3 is being discharged and charged afresh, and that the kiln A^4 has just been fired and is now cooling, then the action of the four kilns will take place as follows: All the passages from the gas generator to the kilns will be closed excepting the one at e^1; the damper will be placed in the passage a^2, shutting off the communication between the kiln A^2 and A^3; all the communications with the flue H leading to the chimney will be closed with the exception of G^2. Combustible gas will now enter at the top of the kiln A^1 through the passage a^4, at the same time atmospheric air will enter through the open kiln A^3, will pass through the hot contents of the kiln A^4, and become considerably heated; it will then pass through the passage X to the kiln A^1, where it will mix with the combustible gases; these will then be ignited and produce considerable heat, by which the contents of the kiln will be burnt. The hot products of this combustion will then pass down to the bottom of the kiln, and thence through the passage a^1 to the top of the kiln A^2; they will then pass downwards through the contents of this kiln, which will absorb the greater part of the heat from these gases, which will eventually escape through the opening G^2 into the flue H conducting to the chimney. After a time the valve in the branch e^1 will be closed and that in E^1 opened, so that the combustible gases will pass in to the middle of the bricks and be there ignited, so as to burn the bricks equally throughout. When this has been completed and the bricks in the kiln A^2 have become heated to a considerable degree, the valve at E^1 is closed, whilst that at e^2 is opened. The kiln A^3 having in the meantime been charged and the openings I^3 closed up, the damper is removed from the passage a^2 to the passage a^3, shutting off the communication between the kilns A^3 and A^4. The contents of this latter having become cooled it is opened and discharged; cool air enters through it, passes through the passage X into the kiln A^1, where it becomes heated by passing down between the hot bricks and then enters the kiln A^2, which is to be fired. The opening G^2 from the kiln A^2 into the flue H having been closed, and the one G^3 in the kiln A^3 opened, the hot products of the combustion taking place in the kiln A^2 pass hence down through the kiln A^3 freshly piled with materials, which absorb the greater part of their heat, and thus cooled they escape through the opening G^3 into the flue H. In this manner it will be

seen that each kiln is in rotation charged with bricks or other objects to be burnt, is then made to absorb the heat from the products of combustion, is fired, is then cooled by the passage of atmospheric air serving to support combustion in another kiln, and is lastly discharged and charged afresh. To allow of the perfect circulation of the hot gases and air at the bottom of the kilns, they are there provided with a series of dwarf walls *f f f*, having spaces between them, upon which walls the bricks or other objects are piled. The hot products of combustion always passing through the bricks in a downward direction, thereby burn them much more uniformly than if the currents passed in an upward direction, as in the latter case partial currents are liable to be formed acting in a partial manner on the bricks. These kilns may also be charged with earthenware instead of bricks, or they may be filled with saggers containing porcelain. Instead of being placed in a row they may also be arranged in a circle, and instead of only employing four compartments any number may be added to the system.

241 The gas generator C is precisely similar in construction to those described with reference to figures 1, 2, 3, 4, and 5, on sheet I, with the exception that the generator being here below the level of the kilns, the vertical pipe for taking off the gases is here dispensed with, as the gases pass at once through the opening *d* into the passage B, whence they rise up and pass into the kilns, as already described. A streamlet of water may here also be introduced into the generator for the purpose as hereinbefore described.

In figure 18 is shewn an arrangement in which our improved regenerative gas furnace is employed for the purpose of heating retorts, either for the manufacture of gas or for any other process which has to be carried on in retorts, such as zinc retorts, muffles, &c.

A is the furnace, in which may be fixed any number of retorts, B B B; C C^1 are the regenerators for heating the combustible gases and air which undergo combustion in the furnace, and for taking up the heat resulting from this combustion in the manner already described with reference to other arrangements.

Having now described the nature of our invention and the best modes we are acquainted with of performing the same, we wish it to be understood that we do not confine ourselves to the precise details shewn on the accompanying drawings; but we claim as our invention the various arrangements of regenerative furnaces worked by the gases resulting from an imperfect combustion of solid fuel in separate places as hereinbefore set forth.

In witness whereof I, the said Charles William Siemens, have hereunto set my hand and seal this nineteenth day of July, in the year of our Lord one thousand eight hundred and sixty-one.

C. W. SIEMENS. [L. S.]

C. D. ABEL.

(Here follow diagrams marked pp. 242*a* & 242*b*.)

243 DEFENDANTS' EXHIBIT DETMOLD PATENT, AS ASSIGNEE OF FABER DU FAUR, NO. 2558, OF APRIL 16TH, 1842. C. F. Z., N. P., November 28th, 1882.

THE U. S. PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the letters patent granted Christian Edward Detmold, dated April 16th, 1842, antedated November 12th, 1841, No. 2558, for "improvements in heating furnaces, &c."

In testimony whereof I, J. M. Thacher, Acting Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this first day of July, in the year of our Lord one thousand eight hundred and seventy-two, and of the Independence of the United States the ninety-sixth.

[Patent Office United States of America.]

J. M. THACHER,
Acting Commissioner.

No. 2558.

THE UNITED STATES OF AMERICA.

To all to whom these letters patent shall come:

Whereas Wilhelm von Faber du Faur, Wurtemberg, has alleged that he has invented a new and useful improvement in heating furnaces, &c. (having assigned his right, title, and interest in the said improvement to Christian Edward Detmold, New York), which he states has not been known or used before his application, has
244 made oath that he is a subject of the King of Wurtemberg; that he does verily believe that he is the original and first inventor or discover of the said improvement, and that the same hath not, to the best of his knowledge and belief, been previously known or used; has paid into the Treasury of the United States the sum of three hundred dollars, and presented a petition to the Commissioner of Patents signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose.

These are, therefore, to grant, according to law, to the said Christian Edward Detmold, his heirs, administrators, or assigns, for the term of fourteen years from the twelfth day of November, one thousand eight hundred and forty-one, the full and exclusive right and liberty of making, constructing, using, and vending to others to be used, the said improvement, a description whereof is given in the words of the said Wilhelm von Faber du Faur in the schedule hereunto annexed, and is made part of these presents.

In testimony whereof I have caused these letters to be made patent, and the seal of the Patent Office has been hereunto affixed.

Given under my hand, at the city of Washington, this sixteenth day of April, in the year of our Lord one thousand eight hundred

and forty-two, and of the Independence of the United States of America the sixty-sixth.

[L. S.] DANIEL WEBSTER,
Secretary of State.

Countersigned and sealed with the seal of the Patent Office.
HENRY S. ELLSWORTH,
Commissioner of Patents.

245 *The Schedule Referred to in these Letters Patent, and making part of the same.*

To all whom these presents shall come:

Be it known that I, William von Faber du Faur, of Wasseralfingen, in the Kingdom of Wurtemberg, director of mines of his majesty the King of Wurtemberg, have invented a new and useful method of generating and applying heat, of which the following is a full and exact description:

It is known that a large quantity of combustible gas called the carbonic oxide gas is formed in all blast and other furnaces, most of which escapes unconsumed, and may be seen burning with a blue flame at the tops of blast and other furnaces. I have invented a method of using this gas as a fuel, and of producing thereby a most intense heat, which may with great ease and convenience be used in the manufacture of iron and other metals, of glass and pottery, to steam boilers, to forges, and generally wherever a high temperature is required. It may also be advantageously applied to heating the hot-air apparatus of blast furnaces where the hot-air blast is used. This apparatus, unless heated by separate fuel, is generally placed on the top of the blast furnace, where it is heated by the waste flame and heat escaping out of the furnace mouth.

By the application of my invention the hot-air apparatus may be located below, on a level with the hearth of the blast furnace and close to the forms, and thus the air will enter the furnace at a much higher temperature than when the apparatus is on top, and the heated air conveyed down by pipes. I collect the carbonic oxide gas from blast, cupola, and other furnaces, or from furnaces constructed expressly for the purpose of producing it, and conduct it to the refinery, puddling, ore-heating, or other furnaces requiring to be heated.

By means of any ordinary blowing machine heated atmospheric air is there forced through a system of blow-pipes among the inflammable gas.

Thus the oxygen of the air becomes thorougly incorporated with the gas, so that when ignited its combustion will be completely effected, and a heat produced sufficiently high for any kind of manufacture.

246 My invention, therefore, consists—

1st. In a new method of using carbonic oxide gas as a fuel.

2dly. In the method employed to obtain the carbonic oxide gas,

so as to have it in a pure and uninflamed state, and of conveying it to the furnaces to be heated by its combustion.

3dly. In a new method of employing the blow-pipe in furnaces, by which continuous jets of highly-heated atmospheric air are mixed with the gases that are to be burned in them, thus effecting their complete combustion.

To explain more fully my invention, and to enable those skilled in the art to use it, I proceed to describe the apparatus by which the gas is obtained and used.

First the mode of obtaining the gas, in the description of which reference is made to plate No. 1 of the annexed drawings making part of this specification, in all the figures on which the same letters refer to the same parts throughout. Fig. 1 is a vertical section through the middle of a blast furnace. Fig. 2 is a horizontal section of the same through the line *x x*.

a a a a a a are six recesses in the interior wall of the furnace, by which the passages *b b b b b b* open into the fire-room of the furnace at or little above the highest point where the fuel is in a state of full combustion, which is generally from 8 to 10 feet below the mouth of the furnace.

The passages *b b b b b b* open into the annular reservoir *c c*, which surrounds the whole of the inner wall of the furnace, and opens into the iron pipe or duct *e e*. The gas ascends through the passages *b b b b b b* into the reservoir *c c*, whence it is led by the *e e* into the furnaces which require to be heated.

The gas may be conducted any distance, but if carried more than one hundred feet from the blast furnace it may be found necessary to reheat it, as it will only burn advantageously at a high temperature.

The annular reservoir *c c* is arched over with fine brick, but has six openings, *d d*, immediately over the passages *b b b b b b*, which are closed by iron plates; these plates may be removed for the purpose of enabling workman to examine and clean the annular reservoir *c c* and the passages *b b b b b b*. The recesses *a a a a a a* are cut in about 12 inches deep at top, and extend down 3 feet 6 inches, so as to permit the charges in the furnace to spread out, and thus to enable the gas more freely to ascend into the passages *b b b b b b*.

247 The passages *b b b b b b* are 1 foot 6 inches wide and 8 inches high. The reservoir *c c* is 1 foot 6 inches high to the crown of the arch.

This invention may also be applied to a blast furnace while in operation, without stopping or blowing it out, by inserting one or more iron pipes lined with fire-proof material into the furnace at about the same height as the recesses *a a a a a a* in Fig. 1. By means of such pipe or pipes the gas will be drawn off, and may be conducted to the furnaces where it is to be used.

I have used also other methods for collecting and drawing off this combustible gas from the blast furnaces, as, for instance, by inserting an iron cylinder into the furnace mouth so as to bring its bottom about 8 or 10 feet below the mouth, thus forming a concentric or

annular chamber between the outside of the cylinder and the interior of the wall of the furnace, which chamber must be closed on top. The furnace is charged through the cylinder, and the gas will ascend into the annular chamber, whence it may be conducted in a similar manner as above described.

An iron tube may also be inserted into the mouth of the furnace, and allowed to descend about 8 or 10 feet. A large portion of the combustible gas will ascend into this pipe, and may thence be carried to the furnaces requiring to be heated.

But the method first above described and illustrated by Figs. 1 and 2, plate 1, I find the best in practice. In cases where there is no blast or other furnace from which the gas may be collected, a separate furnace may be built for the purpose of generating the gas. This furnace may be constructed like a small blast furnace, with a blowing apparatus sufficient to produce a slow combustion. This will produce the requisite quantity of carbonic oxide gas, which, by an arrangement like that described above, may be conducted to the furnace which is to be heated.

Secondly. I proceed to explain the manner of burning the gas, in the description of which reference is made to plates Nos. 3, 4, 5, and 6 hereto annexed, making part of this specification, in all the figures of which the same letters refer throughout to the same parts. The furnaces heated by the combustion of the carbonic oxide gas differ from those heated in the methods now practised principally in these points:

248 They have neither fire-grate nor chimney, but are constructed with a very long fire bridge, and the combustion of the carbonic oxide gas is effected by the forcing into it atmospheric air that has been previously heated in the furnace itself to about 600° Fahrenheit.

I proceed to describe the application of my invention to a puddling furnace for the sake of clearness and precision, it being understood that it is equally applicable to refinery, reheating, or mill furnaces, or to any other furnaces, ovens, or boilers in which a high temperature is required.

Figs. 3, 4, 5, 6, and 7, plates 3, 4, 5, and 6, show different sections of a gas puddling furnace.

Its general dimensions, including the iron plating which encloses the masonry, are 13 feet 2 inches long, 4 feet 5 inches high, and 4 feet — inches wide. The mode of binding the walls together and the cast-iron plating or armature are much the same as in the ordinary puddling furnaces.

The side walls are 1 foot thick, of fire-brick; the fire bridge *c c*, the throat M, and the arches *n n' n''* are also constructed of fire-brick. The other parts of the masonry are of ordinary brick. Fig. 3 is a front view of the furnace. Fig. 4 is a vertical section lengthwise through the furnace. Fig. 5 is a horizontal section through the air chamber B B and the blow pipes *b b b b b b*, showing the plan of the furnace. Fig. 6 is a vertical cross-section through the bridge *c c*, showing the position of the blow pipes. A A is the gas chamber, into which the gas is conducted from the blast or other furnaces

when it is generated through the pipe *e e* (*vide* plate 1, Fig. 1). This gas chamber is made of cast iron, and extends entirely across the end of the furnace and communicates directly with the pipe *e e* (plate 1, Fig. 1). It is 1 foot 2 inches wide in the clear and 10 inches high. In the front or side towards the hearth of the furnace there is an oblong horizontal opening, *a a a* extending in length the whole width of the fire bridge *c c*, or 2 feet 6 inches and 6 inches high.

Through this opening the gas streams into the furnace. B B is a semicircular cast-iron air chamber, 2 feet 4½ inches in diameter and 2½ inches high, into which the hot air is brought through the *p p*. The hot-air chamber, or wind box, is provided with a flange, by means of which it is fastened to the back of the gas chamber
249 A A, which has an opening in the back corresponding exactly to the opening of the air chamber B B.

From the hot-air chamber issue a series of blow-pipes, *b b b b b b b*, made of wrought iron or other metal, of 1½ in diameter at the largest, and 1 inch at the smallest, end or mouth, and 1 foot 6 inches long. These blow pipes pass through the gas chamber A A towards the fire bridge, and project about ½ inch through the opening *a a a*; they incline slightly downwards towards the hearth of the furnace. *c c* is the fire bridge; it is 2 feet 5½ inches long, 2 feet 6 inches wide, and 7½ inches high; it is arched over with fire-brick, and, like the blow pipes, slightly inclines to the hearth of the furnace. D D is the main chamber of the furnace; it is 5 feet 8 inches long, and, measuring from the plate which supports the hearth, it is 1 foot 2¼ inches high at the termination of the bridge *c c*, 1 foot 4 inches in the centre, and 10 inches at the end or beginning of the throat H. The main chamber D D is arched over with fire-brick. G G is the hearth of the furnace; it is formed as in ordinary puddling furnaces, of scoria and fire-proof material about 3 inches thick.

The hearth is supported by a large cast-iron plate, E E E E, which is shown by red dotted lines in Fig. 5, plate V. The middle part is formed by a separate plate, F F, as shown by red dotted lines in Fig. 5, plate V, and which may be replaced by a new one whenever required.

The hearth is surrounded by heavy pieces of cast iron *o o′ o″ o‴*. The back of the hearth and chamber D D is formed of three cast iron pieces, *o′ o′ o′*, laid on top of each other, as shown in Fig. 7, plate VI. To protect the pieces *o* and *o″* from the injurious effects of the intense heat in the main chamber D D they are cast hollow, and a stream of cold water is made to circulate through them, which passes out in front of the furnace at *x*, and entering again at *y*, through the leaden pipe *z z*, is finally discharged in the rear of the furnace. H is the throat of the furnace; it is 1 foot 7 inches long, 3 inches high, and 2 feet 6 inches wide, and is arched over with fire brick. K is the fore-warming chamber, where the iron is heated to a cherry red by the waste heat and flame before it is placed on the hearth G G to be puddled. The opening L serves as a door to the fore-warming chamber K; it is kept

annular chamber between the outside of the cylinder and the interior of the wall of the furnace, which chamber must be closed on top. The furnace is charged through the cylinder, and the gas will ascend into the annular chamber, whence it may be conducted in a similar manner as above described.

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I proceed to describe the application of my invention to a puddling furnace for the sake of clearness and precision, it being understood that it is equally applicable to refinery, reheating, or mill furnaces, or to any other furnaces, ovens, or boilers in which a high temperature is required.

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The hearth is surrounded by heavy pieces of cast iron *o o′ o″ o‴*. The back of the hearth and chamber D D is formed of three cast iron pieces, *o′ o′ o′*, laid on top of each other, as shown in Fig. 7, plate VI. To protect the pieces *o* and *o″* from the injurious effects of the intense heat in the main chamber D D they are cast hollow, and a stream of cold water is made to circulate through them, which passes out in front of the furnace at *x*, and entering again at *y*, through the leaden pipe *z z*, is finally discharged in the rear of the furnace. H is the throat of the furnace; it is 1 foot 7 inches long, 3 inches high, and 2 feet 6 inches wide, and is arched over with fire brick. K is the fore-warming chamber, where the iron is heated to a cherry red by the waste heat and flame before it is placed on the hearth G G to be puddled. The opening L serves as a door to the fore-warming chamber K; it is kept

closed by the plate M, which may be removed as required.
250 P P P P is a system of air pipes into which the air is forced by the blowing machine through the *p'*. The waste heat and flame circulate around the pipes P P P P, thus heating the air in them to a very high temperature, which is thence led by the pipe *p* into the hot-air chamber or wind box B B. Q is a narrow opening of 1 foot 6 inches by 4 inches, out of which the flame finally escapes. R, in Fig. 3, plate 3, is the main door of the furnace; it is suspended by a chain from brick to prevent it being burnt. *r* is a small opening in the door R, which is kept closed by an iron plate, except when the puddler is operating. The pipes *e e*, Fig. 1, plate 1, through which the gas enters the gas chamber A A in the furnace, and the pipe *p p*, through which the heated air is forced into the hot-air chamber B B, are provided with cocks or slide valves, by which the quantity of gas and air to be admitted into the chamber D D may be regulated.

The current or draught created by the air being forced through the blow pipes assists greatly in withdrawing the gas from the blast furnace. The air that is forced into the gas furnace should be heated to about 500° to 600° Fahrenheit. When a gas furnace is to be put in operation the valves in the gas and hot-air pipes are opened a little to enable the gas and hot air to stream in. The gas is then ignited and allowed to burn for about ten or twelve hours with a gentle flame, so as gradually and thoroughly to dry the masonry of the furnace and to warm the furnace through. After this the valves are gradually opened more, until the whole chamber of the furnace is heated equally to a white heat. The iron is then fore-warmed to a cherry red in the chamber K, and then placed, in pieces of about 12 inches square, upright on the hearth, fronting the fire bridge, so as to make a charge of about 3½ cwt. The operation of puddling in a gas furnace is much the same as in any ordinary puddling furnace, with this chief difference, that the iron is subjected to the full heat during the whole operation, instead of increasing or diminishing the heat according to the different stages in the process of puddling as now practised. It is important, in order to avoid the loss of metal as much as possible during the process of puddling, to admit only so much air into the chamber of the furnace that the gas shall always slightly predominate in quantity. This is indicated by the color of the flame that escapes out of the opening Q, which in this case is slightly blue; but when this
251 is not the case, the escape flame is nearly white, and playing slightly into red.

The same precaution is necessary in all the other gas furnaces employed in the manufacture of bar iron. The refinery and reheating or mill furnaces are built on the same principle, and very much in the same manner as the gas-puddling furnace, varying but slightly in their dimensions, and making any further description of them unnecessary, as the above description of the gas-puddling furnace fully elucidates the nature and application of my invention.

The advantages resulting from this invention are:

closed by the plate M, which may be removed as required.
250 P P P P is a system of air pipes into which the air is forced by the blowing machine through the *p'*. The waste heat and flame circulate around the pipes P P P P, thus heating the air in them to a very high temperature, which is thence led by the pipe *p* into the hot-air chamber or wind box B B. Q is a narrow opening of 1 foot 6 inches by 4 inches, out of which the flame finally escapes. R, in Fig. 3, plate 3, is the main door of the furnace; it is suspended by a chain from brick to prevent it being burnt. *r* is a small opening in the door R, which is kept closed by an iron plate, except when the puddler is operating. The pipes *e e*, Fig. 1, plate 1, through which the gas enters the gas chamber A A in the furnace, and the pipe *p p*, through which the heated air is forced into the hot-air chamber B B, are provided with cocks or slide valves, by which the quantity of gas and air to be admittod into the chamber D D may be regulated.

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The same precaution is necessary in all the other gas furnaces employed in the manufacture of bar iron. The refinery and reheating or mill furnaces are built on the same principle, and very much in the same manner as the gas-puddling furnace, varying but slightly in their dimensions, and making any further description of them unnecessary, as the above description of the gas-puddling furnace fully elucidates the nature and application of my invention.

The advantages resulting from this invention are:

1st. A more intense and equal heat than can be obtained from any other fuel now in use.

2dly. Greater facility of converting cast into bar iron.

3dly. Diminished loss of metal in the operations of refining, puddling, and reheating the iron.

4thly. Complete and effective combustion of the fuel used in the furnaces, and consequently the entire avoiding of all smoke and a most important economy of fuel.

What I claim as my invention and wish to secure by letters patent are the following points:

First. The employing carbonic oxide gas as a fuel in combination with a proper proportion of highly-heated atmospheric air in all furnaces for metallurgic operations, and in the heating of all other ovens, boilers, or furnaces.

Secondly. The above-described modes of collecting and drawing the carbonic oxide gas in a pure and uninflamed state from blast and other furnaces, whence it generally escapes in large quantities unconsumed.

Thirdly. The application of the blow-pipe to furnaces, substantially in the manner above described, by which continuous jets of highly-heated atmospheric air forced among the gases in the furnace, thus enabling the oxygen of the atmospheric air to become thoroughly incorporated with the inflammable gas in the furnace, and thereby offecting its complete combustion, and consequently a most intense temperature.

I do not claim the discovery of the existence of the carbonic oxide gas, or of its combustibility; nor do I claim the mode of constructing the blast and other furnaces above described, excepting only so far as such construction embraces the apparatus for collecting
252 and conveying the gas, and the combination of the gas chamber, air chamber, blow pipes, and the long fire-bridge.

W. V. FABER DU FAUR.

Witness:
K. HUTTENVERIVALTUNGR.

Ex'd M. J.

(Here follows diagrams, marked pp. 253, 254, & 255.)

256 DEFENDANTS' EXHIBIT DETMOLD PATENT, AS ASSIGNEE OF FABER DU FAUR, REISSUE No. 67, OF JANUARY 23D, 1845. C. F. Z., N. P. November 28th, 1882.

THE U. S. PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissued letters patent granted C. E. Detmold, dated January 23d, 1845, No. 67, for "Improvement in Heating Furnaces, &c."

In testimony whereof I, J. M. Thacher, Acting Commissioner of Patents, have caused the seal of the patent office to be hereunto

affixed this first day of July, in the year of our Lord one thousand eight hundred and seventy-two, and of the Independence of the United States the ninety-sixth.

[Patent Office United States of America.]

J. M. THACHER,
Acting Commissioner.

No. 67.

UNITED STATES OF AMERICA.

To all to whom these letters patent shall come:

Whereas, C. E. Detmold, of the city of New York, assignee of Wilhelm von Faber du Faur, of Wasser-Alfingen, Europe, has alleged that the said Wilhelm von Faber du Faur has invented a new and useful improvement in heating furnaces, &c. (said W. v. Faber du Faur, having assigned his right, title, and interest in the said improvement to the said C. E. Detmold), for which letters patent were granted to the said Detmold in the United States, issued on the 16th day of April, 1842, running from the 12th day of November, 1841, that being the date of letters patent granted said W. v. Faber du Faur by the King of Wurtemberg, but it being since ascertained that they should run from the
257 12th day of May, 1840, the date of the original letters patent granted to the said W. v. Faber du Faur by the King of Bavaria, the correction is accordingly made, which letters patent are hereby cancelled on account of a defective specification, which he states has not been known or used before the said W. v. Faber du Faur's application, has made oath that he is a citizen of the United States; that he does verily believe that the said W. v. Faber du Faur is the original and first inventor or discoverer of the said improvement, and that the same hath not, to the best of his knowledge and belief, been previously known or used; has paid into the Treasury of the United States the sum of fifteen dollars, and presented a petition to the Commissioner of Patents signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose.

These are therefore to grant, according to law, to the said C. E. Detmold, his heirs, administrators, or assigns, for the term of fourteen years from the twelfth day of May, one thousand eight hundred and forty, the full and exclusive right and liberty of making, constructing, using, and vending to others to be used, the said improvement, a description whereof is given in the words of the said C. E. Detmold in the schedule hereunto annexed, and is made part of these presents.

In testimony whereof I have caused these letters to be made patent, and the seal of the Patent Office has been hereunto affixed.

Given under my hand at the city of Washington this twenty-third day of January, in the year of our Lord one thousand eight hundred and forty-five, and of the Independence of the United States of America the sixty-ninth.

[L. S.]

J. C. CALHOUN,
Secretary of State.

Countersigned and sealed with the seal of the Patent Office.

HENRY S. ELLSWORTH,
Commissioner of Patents.

258 *The Schedule Referred to in these Letters Patent and Making Part of the Same.*

To all persons whom it may concern:

Be it known that the following is a full and exact description of a new and useful invention for generating and applying heat, made by Wilhelm von Faber du Faur, of Wasser-Alfingen, in the kingdom of Wurtemberg.

In all blast and other furnaces employed in the manufacture of iron and other metals, a large quantity of combustible gases, principally consisting of the carbonic oxide gas, is generated and escapes unconsumed out of the furnaces.

I have discovered and invented a new mode of employing other otherwise lost gases usefully, and of producing by their combustion a most intense temperature, which may be applied with great advantage in the manufacture of iron and other metals, to the heating of steam boilers, and generally wherever a high temperature is required.

I collect these combustible gases from blast, cupola, and other furnaces, or fireplace, or from furnaces constructed for the express purpose of producing them, and conduct them to the other furnaces or structures that are to be heated by them, where their combustion is effected by mixing with them an adequate quantity of heated air in numerous small streams under a pressure greater than that of the atmosphere.

This may be done by forcing the heated air through apertures in the sides of pipes or other apparatus, but is best effected by forcing it admidst the combustible gases through a system of blow-pipes.

Thus the oxygen of the atmospheric air becomes thoroughly incorporated with the combustible gases, so that their combustion is at once completely effected, and a heat produced sufficiently high for any kind of manufacture.

My invention, therefore, consists—

1. In a new mode of obtaining and collecting carbonic oxide and other combustible gases from blast and other furnaces or fire-places, or from furnaces constructed for the express purpose of producing the same.

259 2. In a new mode of effecting the perfect combustion of the gases so obtained.

Having thus generally stated the character of my invention, I will describe more particularly its application to the manufacture of iron.

In the first place I will describe the mode of obtaining the gases from a blast or smelting furnace, reference being had to the plate No. 1 of the annexed drawings.

Fig. 1 is a vertical section through a blast or smelting furnace.

Fig. 2 is an horizontal section of the same through the line *x x*; *a a a a a a* are six openings or recesses in the in-walls or lining of the furnace, which are made at or near that point of the furnace where the limestone employed as a flux is completely calcined and the reduction or deoxidation of the ores has not yet commenced. This point will generally be at about one-third of the height of the whole furnace below tunnel-head or two-thirds above the bottom stone. The recesses *a a a a a a* communicate by means of the passages or flues *b b b b b b*, with an annular reservoir, *c c*, that surrounds the whole of the in-walls of the furnace.

The pipe or duct D D communicates also with the reservoir *c c*. The resistance offered to the escape of the gases out of the top of the furnace by the mass of coal ores and flux above the openings *a a* will cause a larger portion of the gases to flow into them and to ascend through the flues or passages *b b* into the reservoir *c c*, whence they are conducted by the pipes D D to the furnaces that require to be heated.

The reservoir *c c* is constructed of fire-brick or maybe constructed of iron; it has six openings, *e e*, immediately over the passages or flues *b b*, which are kept closed by plates of iron so arranged that they may be conveniently removed for the purpose of allowing the reservoir and flues to be occasionally cleaned from the dust that collects in them. The pipe D D is provided with a valve or gate, F, by which the admission of the gases to the furnaces, where they are to be used, may be regulated.

The number and size of the openings to be made in the furnace depends on its general dimensions and the quantity of gases to be drawn off. A less number than six will in many instances be found sufficient; nor is the reservoir *c c* for collecting the gases in all cases necessary, inasmuch as the insertion of a pipe into the side of the furnace at the proper height will generally afford the requisite quantity of gas for the heating of a single furnace or for heating the boiler of the blowing engine or for the hot-blast apparatus.

I have used other modes of collecting and drawing off the combustible gases from blast furnaces, as, for instance, by inserting an iron cylinder into the top of the furnace. This cylinder should be sufficiently long so that its lower edge may reach down to the point indicated above as being the most proper for drawing off the gases. The diameter of this cylinder should be about two feet less than the top of the furnace, thus forming an annular chamber between the outside of the cylinder and the in-walls of the furnace, which chamber must be closed on top.

The blast furnace is charged through the cylinder, which must be kept full or nearly so. Thus the gases will ascend into the annular chamber or reservoir, whence they are conducted in a similar manner, as above described, to the furnaces or other structures that are to be heated by them.

This mode of drawing off the gases is exemplified in Figs. 1 and 2, plate III. The mode first described above, and illustrated by Figs. 1 and 2, plate No. 1, I have found, however, the best in prac-

tice. In cases where there is no blast furnace from which the combustible gases may be collected, a separate furnace must be built for the purpose of generating the combustible gases from any kind of fuel. This furnace may be constructed somewhat like a small blast furnace or cupola, which is to be filled with fuel and sufficient air blown into it to produce the requisite quantity of combustible gases, which are conducted thence, in a similar manner as that above described, to the furnaces that are to be heated thereby. This mode of generating combustible gases is illustrated by Figs. 1 and 2, plate No. III.

Secondly. I proceed to describe my invention for effecting the perfect combustion of the gases, after having been obtained in the modes above described, and for the purpose of explaining this part of my improvements more fully. I will describe its application to a furnace for puddling or decarbonizing iron, it being understood that a similar arrangement of parts is applicable to all other processes in the working and manufacture of iron or any other purposes requiring a high temperature.

261 Fig. I, plate No. II, represents a longitudinal vertical section of a puddling furnace.

Fig. 2 is a horizontal section.

Fig. 3 is a vertical cross-section through the line *x x*.

Fig. 4 is a vertical cross-section through the line *y y*, showing the arrangement of the pipes for heating the air.

Fig. 5 is a front view of the furnace.

A A is the gas chamber into which the combustible gases are conducted by means of the pipe D D (*vide* plate 1, Fig. 1). It is best made of cast iron, but may also be built of brick, and extends entirely across the end of the furnace. In the front or side towards the hearth there is an oblong horizontal opening, *a a a*, of the same dimensions as the fire bridge, through which opening the gases stream into the furnace. B B is a cast iron air chamber, into which the hot blast is brought through the pipe *p p;* it is attached to the back of the gas chamber A A by means of a flange and screws. The gas chamber A A has an opening corresponding exactly to the size of the air chamber B B, from which issues a system of six or more blow pipes *b′ b′ b′ b′ b′ b′*, made of wrought iron and slightly tapering towards the mouth, which is flattened a little, the horizontal diameter being about $1\frac{1}{2}$ inch, and the vertical diameter $\frac{3}{4}$ inch. These blow pipes are riveted upon a piece of sheet iron, and interposed between the hot air chamber B B and the back of the gas chamber A A; they are made long enough to project about half an inch through the gas chamber, and are so placed as to incline slightly towards the hearth of the furnace, the same as the fire bridge C′ C′, for the purpose of throwing the flame more directly upon the metal under operation.

The fire bridge C′ C′ is made much longer than in ordinary furnaces, so as to allow the combustible gases and the streams of heated air to become thoroughly combined before reaching the hearth where the metal is worked.

The length of the fire bridge is in some measure regulated by the

pressure of the blast used; 2 feet will generally be found sufficient, but a very powerful blast 2½ feet, and with a blast of feeble pressure 1½ foot will be an adequate length of fire bridge.

D D is the main chamber of the furnace where the metal is worked; its dimensions are the same as in the puddling furnaces of ordinary construction. The hearth or bottom is con-
262 structed of cast-iron plates, the same as in the common puddling furnaces. H is the throat or flue of the furnace K in the working door. I is a door through which the pig-iron or fine metel is charged upon the further end of the hearth for the purpose of heating it by the waste heat before charging it on the main hearth. P P P P is a system of hot-air pipes placed in the chamber L L adjoining the stack E and communicating with it by means of numerous openings *l' l' l' l'* left in the brick partition that separates the chamber from the stack. The burnt gases in their passage out of the stack communicate sufficient heat through these openings to the pipes to heat the blast to the required temperature—say from 300° to 500° Fahrenheit. The pipes P P communicate with the hot-air chamber B through the pipe P″, which is provided with a valve O for the purpose of regulating the quantity of air for the combustion of the gases. E is the stack through which the burnt gases finally escape, and as the combustion of the gases is effected by means of an artificial blast of a pressure greater than the atmosphere these furnaces require no high stack or chimney for creating a draft. When a furnace of this kind is to be put into operation the valve that admits the gases into the chamber A is partially opened so as to admit a small quantity of gas, which is then ignited; after this the valve that admits the air is gradually opened and the gas allowed to burn with a moderate flame until the masonry of the furnace is properly dried, after which the quantity of gas and air is increased by opening the valves so as to heat the furnace to the requisite temperature. Great care must be taken not to admit too large a quantity of gas and air at once, as the sudden ignition of a large volume of combustible gas is apt to crack the masonry of the furnace. After the furnace has been brought to a proper heat the iron is charged the same as in ordinary puddling furnaces, and the operation of puddling is performed the same as usual.

It is important, in order to avoid as much as possible the loss of metal by oxidation during the process of puddling, to admit only such quantity of air through the blow pipes as is necessary to produce the perfect combustion of the gases, of which the workmen can readily judge by the state of the furnace which is cooled by an excess of air.

On the other hand, an excess of gas must also be avoided,
263 as it tends to retard the process of decarbonization. This is readily perceived by the escape of flame from the furnace stack.

The same precautions must be observed with all other gas furnaces employed in the different processes of manufacturing iron.

Plate No. 3, Figs. 1 and 2, represent a gas generating furnace with a refinery attached. Furnaces of this kind for generating combus-

tible gases from any kind of fuel may be employed with great advantage over the ordinary mode of burning the fuel in reverberatory furnaces.

Fig. 1 exhibits a longitudinal vertical section of the gas generator and refinery.

The gas generator is constructed like a small blast furnace; into the top of it is inserted a cast-iron cylinder, *a a*, about twenty inches less in diameter than the upper part of the furnace. The cylinder is supported by a broad flange resting upon the walls of the furnace.

The space *b b* between the exterior of the cylinder and the inside of the furnace, forms an annular chamber, into which the gases that are generated ascend, and whence they pass through the opening *c* into the condensing flue *d d*, into which the iron pipe *e e e* is inserted, which conducts the gases into the refinery or other furnace that is to be heated by them.

The gas generating furnace is filled with coal through the iron cylinder, which must always be kept full to the top, serves to compel all the gases to enter the chamber *b b*; this may also be effected by closing the top of the cylinder by a movable door, to be lifted only when the furnace is charged with coal.

Through tuyeres *g* a sufficient quantity of air is forced into the furnace to produce combustion of the coal; the gaseous products of this combustion will, in their assent through the superincumbent body of ignited coal, be converted into combustible gas, chiefly consisting of the carbonic oxide gas; *f* is an opening through which the coal dust that collects in the bottom of the flue is occasionally cleaned; this opening is kept closed by an iron door; N is a valve, by means of which the quantity of gases to be admitted into the refinery is regulated; *e e e* is the pipe that conducts the gases to the refinery furnace.

The refinery furnace in its general construction is the same as the puddling furnace above described, differing from it chiefly
264 in this, that at the back or front there are two tuyeres, K K, through which heated air is blown upon the melted iron, for the purpose of purifying and in part decarbonizing it. The hot air is supplied from the pipe P P by means of the branches Q Q, which are provided with valves, *g' g'*, by which the supply of air is regulated.

The sides of the main chamber or hearth where the iron is refined are made of solid frames or blocks of cast iron with a wrought-iron pipe of about one inch diameter cast in, through which a stream of cold water is made to circulate for the purpose of protecting them from the intense heat and the destructive action of the melted metal and scoria. These water blocks are shown at *i i i* in Figs. 1 and 2; the water enters at *r* and is discharged at S.

The bottom of the refinery furnaces is made of fire-brick set edgewise, or of fire-sand. I is the tapping hole through which the melted iron is run out after having been refined.

Fig. 2 is a horizontal section.

Fig. 3 is a section through the line *x x*.

The reheating or mill furnaces are much the same in point of

construction and arrangement of parts as the puddling and refinery furnaces above described, differing from them in their dimensions only, and making any further descriprion of them unnecessary, as the above description of the puddling furnace sufficiently elucidates the nature and application of my invention to enable others skilled in the art of constructing and managing furnaces to apply the same to any processes in the manufacture and working of metals, or to the heating of the hot-blast apparatus for blast furnaces or to steam boilers, or to any other purposes requiring a high temperature.

The advantages resulting from the use of my invention are—

1st. A more intense and equal heat than can be obtained by any fuel in the ordinary modes of combustion now in use.

2d. Complete and effective combustion of the fuel, and consequently a most important economy in the same, and the avoiding of all smoke.

3d. Diminished loss of metal from oxidation in the different process of working iron or other metal.

Having thus fully described my invention and improvements in generating and applying heat, I proceed to specify more particularly what I claim as my invention and improvements.

265 1. I claim the collecting and drawing off the combustible gases, chiefly consisting of carbonic oxide gas, from blast and other furnaces, at one or more points below the top of the fuel in said furnaces, substantially as set forth in the above specification, for the purpose of employing said gases instead of other fuel for the heating of all kinds of furnaces used in the various processes of manufacturing and working iron and other metals, and for the heating of steam boilers or any other structures requiring a high temperature.

2. I claim the above described mode, or any other substantially the same, of generating combustible gases from any kind of fuel in separate furnaces or chambers, and conducting the same to other furnaces or structures that are to be heated by the combustion of said gases.

3. I claim the above described mode, or any other substantially the same, of forcing through a system of blow pipes, or in any other convenient manner, heated air in numerous small streams, and under a pressure greater than that of the atmosphere into the said combustible gases in the furnaces or structures where the same are to be used for the purpose of producing, by the rapid and intimate mixture of the heated air with the combustible gases, their immediate and complete combustion.

In testimony whereof I, the said Christian Edward Detmold, subscribe my name in presence of the witnesses whose names are hereto subscribed, on the 8th day of January, A. D. 1865.

C. E. DETMOLD,
Assignee of Wilhelm von Faber du Faur.

Witnesses:
THO. CHAMBER.
R. B. COLUMN.

4360. Ex'd: L. P. H.

(Here follow diagrams, marked pp. 266, 267, & 268.)

269 PHILADELPHIA, *January* 12, 1883.

Present: Henry Baldwin, Jr., Esq., for defendants; Silas W. Pettit, Esq., for complainants.

SIEMENS *et al. vs.* SELLERS *et als.*

The complainants having closed their testimony, defendants' counsel, in pursuance of the notice heretofore given, as found at folio 332, page 84, of complainants' record, offers and puts in evidence as tending to contradict the construction put by the witness, Park Benjamin, on the reissue letters patent 3265. First, a certified copy of reissued letters patent granted to C. William Siemens, of Westminster, England, reissue 7863, dated August 28th, 1877, being a reissue of letters patent No. 89441, dated April 27th, 1869, division B, for improvements in regenerative furnaces, and the same is marked "Defendants' Exhibit C. William Siemens' Reissue 7863. C. F. Z., N. P., Jan. 12th, 1883." Also a certified copy of the reissue No. 7864 of the same tenor and date as said reissue 7863, being division C of reissue of said original patent of 1869 of C. William Siemens, and the same is marked "Defendants' Exhibit. C. William Siemens' Reissue 7864. C. F. Z., Jan. 12th, 1883."

And the defendants' counsel further gives notice that he will use said exhibits at the hearing of this cause for the aforesaid purpose, and will rely in connection therewith upon the admission of complainants' counsel, as found in folio 331, page 84, of complainants' record, that the C. William Siemens, patentee named in said reissues, is one of the complainants herein.

Mr. Pettit objects to the offer, first, because the evidence is immaterial; and, second, because it is not competent as evidence in rebuttal.

The identity of Mr. Siemens is admitted as before.

Defendant closes.

CHARLES F. ZIEGLER,
Special Examiner.

January 12, 1883.

270 DEFENDANTS' EXHIBIT C. WILLIAM SIEMENS' REISSUE 7863. C. F. Z., N. P., Jan. 12th, 1883.

(65.)

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissue letters patent granted C. William Siemens, dated August 28th, 1877, No. 7863, for "improvement in regenerator furnaces."

In testimony whereof I, W. H. Doolittle, Acting Commissioner of

(Here follow diagrams, marked pp. 266, 267, & 268.)

269 PHILADELPHIA, *January* 12, 1883.

Present: Henry Baldwin, Jr., Esq., for defendants; Silas W. Pettit, Esq., for complainants.

SIEMENS *et al. vs.* SELLERS *et als.*

The complainants having closed their testimony, defendants' counsel, in pursuance of the notice heretofore given, as found at folio 332, page 84, of complainants' record, offers and puts in evidence as tending to contradict the construction put by the witness, Park Benjamin, on the reissue letters patent 3265. First, a certified copy of reissued letters patent granted to C. William Siemens, of Westminster, England, reissue 7863, dated August 28th, 1877, being a reissue of letters patent No. 89441, dated April 27th, 1869, division B, for improvements in regenerative furnaces, and the same is marked "Defendants' Exhibit C. William Siemens' Reissue 7863. C. F. Z., N. P., Jan. 12th, 1883." Also a certified copy of the reissue No. 7864 of the same tenor and date as said reissue 7863, being division C of reissue of said original patent of 1869 of C. William Siemens, and the same is marked "Defendants' Exhibit. C. William Siemens' Reissue 7864. C. F. Z., Jan. 12th, 1883."

And the defendants' counsel further gives notice that he will use said exhibits at the hearing of this cause for the aforesaid purpose, and will rely in connection therewith upon the admission of complainants' counsel, as found in folio 331, page 84, of complainants' record, that the C. William Siemens, patentee named in said reissues, is one of the complainants herein.

Mr. Pettit objects to the offer, first, because the evidence is immaterial; and, second, because it is not competent as evidence in rebuttal.

The identity of Mr. Siemens is admitted as before.

Defendant closes.

CHARLES F. ZIEGLER,
Special Examiner.

January 12, 1883.

270 DEFENDANTS' EXHIBIT C. WILLIAM SIEMENS' REISSUE 7863. C. F. Z., N. P., Jan. 12th, 1883.

(65.)

DEPARTMENT OF THE INTERIOR,

UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissue letters patent granted C. William Siemens, dated August 28th, 1877, No. 7863, for "improvement in regenerator furnaces."

In testimony whereof I, W. H. Doolittle, Acting Commissioner of

Patents, have caused the seal of the Patent Office to be hereunto affixed this sixteenth day of February, in the year of our Lord one thousand eight hundred and seventy-eight, and of the Independence of the United States the one hundred and second.

[Patent Office United States of America.]

W. H. DOOLITTLE,
Acting Commissioner.

No. 7863 Reissue.

THE UNITED STATER OF AMERICA.

To all to whom these presents shall come:

Whereas, C. William Siemens, of Westminster, England, has presented to the Commissioner of Patents a petition praying for the reissue of letters patent for an alleged new and useful im-
271 provement in regenerator furnaces (for which letters patent were issued to him, dated April 27th, 1869, which letters having been surrendered, the same have been cancelled, and new letters ordered to issue to him on three separate amended specifications), a description of which invention is contained in the specification, of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of law in such cases made and provided; and

Whereas, upon due examination made the said claimant is adjudged to be justly entitled to a patent under the law;

Now, therefore, these letters patent are to grant unto the said C. William Siemens, his heirs or assigns, for the term of seventeen years from the twenty-seventh day of April, one thousand eight hundred and sixty-nine, the exclusive right to make, use, and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the city of Washington, this twenty-eighth day of August, in the year of our Lord one thousand eight hundred and seventy-seven, and of the Independence of the United States of America the one hundred and second.

[L. S.] A. BELL,
Acting Secretary of the Interior.

Countersigned:
ELLIS SPEAR.
Commissioner of Patents.

272 UNITED STATES PATENT OFFICE.

C. WILLIAM SIEMENS, of Westminister, England.

Improvement in Regenerator Furnaces.

Specification forming part of letters patent No. 89441, dated April 27, 1869. Reissue No. 7863, dated August 28, 1877. Application filed December 5, 1876.

Division B.

To all whom it may concern:

Be it known that I, Charles William Siemens, of Westminster

county of Middlesex, England, have invented certain improvements in regenerative gas furnaces.

The following description, taken in connection with the accompanying plate of drawings, hereinafter referred to, forms a full and exact specification, wherein are set forth the nature and principles of the invention, by which the same may be distinguished from others for which letters patent have heretofore been granted, together with such part thereof as I claim as new and desire to secure by reissued letters patent of the United States.

My invention relates to that class of furnaces known as regenerative gas furnaces, for which letters patent of the United States were granted on the 1st day of March, 1864; and the nature thereof consists, first, in so constructing the air and gas regenerators that the arithmetical ratio of the space occupied by the air regenerators and the space occupied by the gas regenerators, as measured by cubic units, shall be substantially the same as the ratio of the volume of air and the volume of gas required to insure complete combustion; secondly, in the arrangement of the flues leading from the regenerators to the furnace, whereby the heated air is introduced into the furnace at a level superior to that at which the gases enter; thirdly, in combining with the regenerators a series of partition walls for the purpose of separating the air flues from the gas flues and arranging them parallel to each other; fourthly, in the method of sup-
273 porting the furnace by means of buckstaves and tie rods passing through the ventilating space below the furnace bottom; fifthly, in combining with the regenerative furnace a ladle, mounted on wheels, for collecting and thoroughly mixing the molten material before pouring, substantially as herein described.

In the accompanying plate of drawings, in which corresponding parts are designated by similar letters, figure 1 denotes a longitudinal section of the furnace, Fig. 2 is a transverse section on line 16 16, Fig. 1. Fig. 3 represents a rear elevation and a section through the gas passages. Fig. 4 is a front elevation. Fig. 5 is a sectional plan taken on line 19 19, Fig. 1.

In the regenerative gas furnace the gas and air employed are separately heated by the waste heat of the flame, by means of what are termed "regenerators," placed usually beneath the furnace. These are four separate chambers, C C′ E E′, carefully built of fire brick, and the wall whitewashed inside, so as to avoid any leakage from one chamber to the other. They are worked in pairs, so that one pair, *e g* C E, is being constantly heated by the products of combustion on their way to the chimney, while the other pair, C′ E′, is giving up the heat so obtained to the incoming gas and air.

These four chambers are filled with fire brick or other refractory and suitable material, stacked loosely together. The waste gases from the furnace are drawn down through one pair of regenerators and heat the upper rows of bricks to a temperature little short of that in the furnace itself. They then pass over cooler surfaces, and escape at length to the chimney flue nearly cold. The current of hot gases is continued down through this pair until a considerable depth of brick-work near the top is uniformly heated to a tempera-

ture nearly equal to that of the entering gas, the heat of the lower portion decreasing gradually downward at a rate depending on the velocity of the current and the size and arrangement of the bricks. The direction of the draft is then reversed, the current of heated waste gases is employed to heat up the second pair of regenerators, and the gas and air entering the furnace are passed in the opposite direction through the first pair, and, coming into contact, in the first instance, with the cooler brick-work below, are gradually heated as they ascend until at some distance from the top they attain a temperature nearly equal to the initial heat of the waste gases, and passing up into the furnace meet and at once ignite, producing a
274 strong flame, which, after passing through the heating chamber, is drawn down to heat the second pair of regenerators, and thence passes to the chimney flue. The temperature attained by the ascending gas and air remains practically constant, for while one pair of regenerators is being heated the other pair is correspondingly cooled. The air and gas thus flow in a natural manner, being heated as they ascend, and cooled in their descent, so that an artificial draft is only required to draw off the waste gases from the regenerators.

By reversing the direction of the draft at suitable intervals, nearly all the heat is retained in the furnace that would otherwise be carried off by the products of combustion.

When the heat of the furnace is not abstracted continually by work performed in the heating chamber, the temperature necessarily increases after each reversal, as only a very small fraction of the heat generated is carried off to the chimney by the waste gases.

The gas and air in rising through the generator are heated to a temperature nearly equal to that which the flame had when passing down, and when they meet and burn in the furnace the heat of combustion is added to that carried up from the regenerators, and the flame is necessarily hotter than before, and raises the second pair of regenerators to a higher heat. On again reversing, this higher heat is communicated to the gas and air passing in and a still hotter flame is the result.

The advantages of a furnace of the construction above described are that the heat can be raised to an almost unlimited degree; that the flame can be made, at will, oxidizing, neutral, or reducing; that indraft of air and cutting flames are avoided; and that the gaseous fuel is free from ashes, dust, and other impurities.

In order to render these advantages thoroughly available for metallurgical furnaces, to produce a heating flame of the proper length and direction, to mix the air and gas at the very point at which the heat is required, or where it is taken up at once by the materials to be heated or fused, to throw the most intense heat upon the charge, to make the bed of the furnace sufficiently refractory, to prevent the mixture of air and gas until they reach the interior of the heating chamber, to construct the gas and air regenerators of proper size in reference to each other, to prevent bad effects arising from expansion, and to facilitate the working of the regenerators by means of
275 improved valves, I have found by actual experiment that a

regenerative gas furnace different in construction and operation from that heretofore patented by myself and Frederick Siemens is necessary.

Having reference to the accompanying drawings, I will proceed to describe a regenerative gas furnace having the improvements protected by the present letters patent applied thereto.

The regenerative gas furnace, as shown in the drawings, is built of fire-brick or other suitable refractory material, and consists of the four regenerators with their flues and valves, and the heating chamber where the metallurgical operations are carried on.

The four regenerators are arranged in pairs and vary in size, the smaller being used for the passage of gas and the larger for that of air, their proportions being in the ratio of two to three approximately. These ratios correspond to the quantities of gas and air required to insure complete combustion in the heating chamber. The walls of the regenerators are built of fire-brick, or other suitable refractory material, closely laid and whitewashed, or otherwise made gas-tight, so that no leakage may take place from one chamber to another.

These chambers are filled with refractory material, by preference fire-brick stacked loosely together, and each regenerative chamber has its own separate flue at the base communicating with the valves by which the gas and air enter, or the products of combustion pass out, while from the top of side of each regenerative chamber a flue passes upward and communicates with the heating chamber; and I prefer to cause the air to enter the heating chamber above the gas, as by its superior specific gravity at equal temperatures it tends to sink through the gas, and thus an intimate mixture and more perfect combustion are obtained.

The entering or issuing gaseous currents pass through valves, which are shown at X in Figs. 2 and 3. Each valve consists of three parts, viz., a central piece, wherein is placed the reversing flap, which directs the course of the currents, and above which is the throttle-valve which regulates the admission of gas and air, and two side boxes, Z Z, furnished with covers Z′ Z′, for cleaning purposes. These side boxes, Z Z, are placed between the flues leading to or from the regenerators and the chimney flue, and in practical working they are of great service, inasmuch as they simplify construction
276 and prevent overheating and consequent warping of the reversing flaps. Thus leakage is avoided, the currents are kept separate, and their reversal easily effected.

The heating chamber, where the metallurgical processes are carried on, has its roof and sides constructed of highly-refractory materials, such as best silica or Dynas bricks.

The bed is cooled below by an air space, and through this space pass special tie rods, which, together with others above the roof, serve, in combination with suitable buckstaves, to maintain the whole chamber in a solid condition.

On first lighting the furnace the gas passes through the proper valves and flues into the bottom of the regenerator chamber C, while the air enters through corresponding valves and flues into the re-

generator chamber E, which should be about one-half larger than the gas-regenerator chamber C. The currents of gas and air, both quite cold, rise separately through the regenerators C and E and pass up through the flues or series of flues G G G and F F F F, respectively, into the furnace above, where they meet and are lighted, burning and producing a moderate heat.

The gas flues G G G, communicating between the regenerator C and the furnace, are separated from the air flues F F F F, leading to the regenerator E by a series of partition walls, P, and the partition walls S, between the air flues and the furnace, are extended upward in such manner that the currents of air from the regenerator E will enter the furnace above the currents of gas from the regenerator C. The products of combustion pass away through a similar set of flues at the other end of the furnace into the regenerator chambers C′ E′, and thence, through properly constructed flues and valves, to the chimney flue. The waste heat is thus deposited in the upper courses of open fire-brick work, filling the chambers C′ E′, and heats them up, while the lower portion and the chimney flue are quite cool; then, after a suitable interval, the reversing flaps, through which the air and gas are admitted or withdrawn from the furnace, are reversed, and the air and gas enter through those regenerator chambers E′ C′, which have just been heated by the waste products of combustion, and in passing up through the checker work they become heated, and then, on meeting and entering into combustion in the furnace D, they produce a very high temperature, the
277 waste heat from such higher temperature of combustion heating up the previously cold regenerators C E to a corresponding higher heat. Thus an accumulation of heat and an accession of temperature are obtained step by step, so to speak, until the furnace is as hot as required. The heat is at the same time so thoroughly abstracted from the products of combustion by the regenerators that the chimney flue remains comparatively cool. The command of the temperature of the furnace and of the quality of the flame is rendered complete by means of gas and air regulating valves and by the chimney damper.

Having thus described my invention, I claim and desire to secure by letters patent of the United States—

1. A regenerative gas furnace in which the air-regenerator is as much larger than the gas regenerator as the volume of air required to insure complete combustion is larger than the volume of gas.

2. A regenerative gas furnace in which the air is introduced at a level superior to that at which the gas enters, as and for the purposes described.

3. A regenerative gas furnace in which the air-flues are separated from the gas-flues by a series of partition walls, as and for the purposes described.

4. A regenerative gas furnace in which both gas and air flues are arranged above the gas regenerators.

5. A regenerative furnace in which the partition walls between the air-flues and the furnace, the partition wall between the flues

4 Sheets—Sheet 4.

C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,863. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs.
Sellers et al. } p. 281

Fig. 4

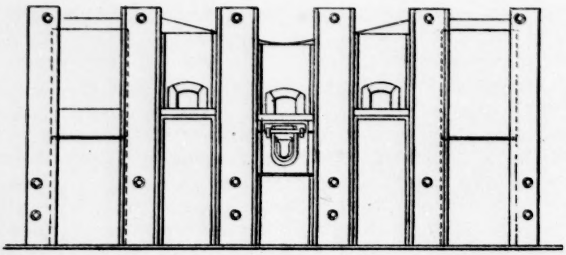
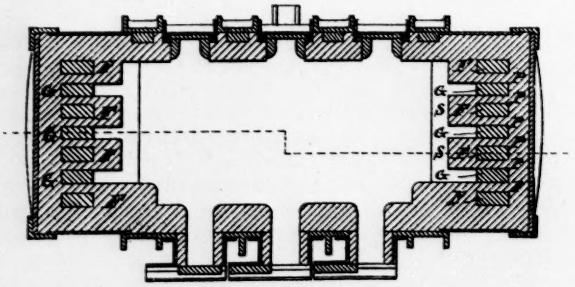


Fig. 5.



Witnesses.
Joseph R. Wildman
W. T. Otterbourg

Inventor.
Charles William Siemens
by Charles S. Whitman
attorney

4 Sheets—Sheet 3.

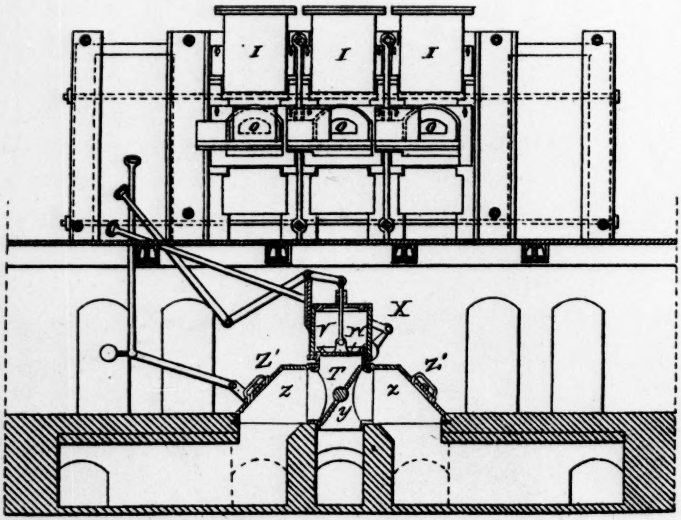
C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,863. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs
Selleus et al.
p 280

Fig. 3.



Witnesses.
Joseph C. Whitman
W. F. Whittemore

Inventor
Charles William Siemens
by Charles S. Whitman
attorney

4 Sheets—Sheet 1.

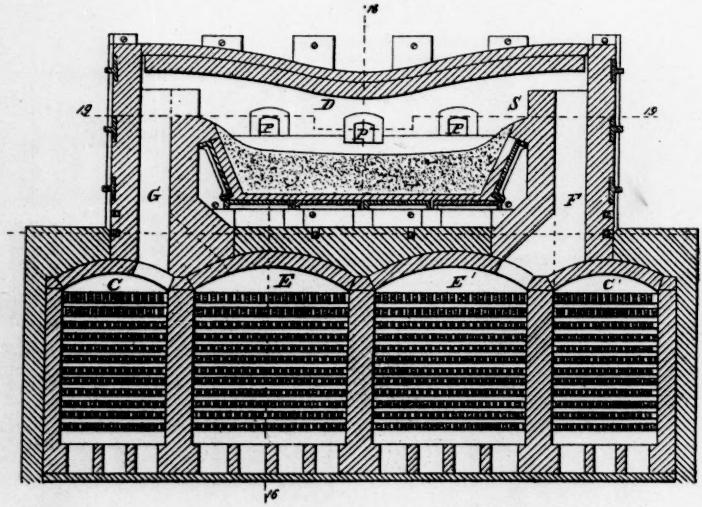
C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,863. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs.
Sellers et al.
} p. 278

Fig. 1.



Witnesses.
Joseph C. Wildman
W. J. Hutchinson

Inventor.
Charles William Siemens
by Charles S. Whitman
attorney

and the ventilating space, and partition walls between the air and gas regenerators are arranged in the same vertical plane.

6. A regenerative gas furnace in which the tie-rods are passed through the ventilating space below the furnace bottom, as and for the purposes described.

7. A ladle mounted on wheels, in combination with the regenerative gas furnace, as and for the purposes described.

In testimony that I claim the foregoing I have hereunto set my hand and seal this 26th day of June, 1876.

C. WILLIAM SIEMENS. [L. S.]

Witnesses—
CHARLES ROCHE,
G. D. DAVIS.

(Here follow diagrams marked pp. 278, 279, 280, & 281.)

282 DEFENDANTS' EXHIBIT C. WILLIAM SIEMENS' REISSUE 7864.
C. F. Z., N. P., Jan. 12th, 1883.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE.

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissue letters patent granted C. William Siemens, dated August 28th, 1877, No. 7864, for "Improvement in Valves for Regenerator Furnaces."

In testimony whereof I, W. H. Doolittle, Acting Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this sixteenth day of February, in the year of our Lord one thousand eight hundred and seventy-eight, and of the Independence of the United States the one hundred and second.

[Patent Office, United States of America.]

W. H. DOOLITTLE,
Acting Commissioner.

No. 7864 Reissue.

THE UNITED STATES OF AMERICA.

To all to whom these presents shall come:

Whereas C. William Siemens, of Westminster, England, has presented to the Commissioner of Patents a petition praying for the reissue of letters patent for an alleged new and useful improvement in valves for regenerator furnaces (for which letters patent were issued to him, dated April 27th, 1869, which letters having been sur-
283 rendered, the same have been cancelled, and new letters ordered to issue to him on three separate amended specifications), a description of which invention is contained in the specification, of which a copy is hereunto annexed and made a part hereof, and has complied with the various requirements of law in such cases made and provided; and

Whereas, upon due examination made, the said claimant is adjudged to be justly entitled to a patent under the law:

Now, therefore, these letters patent are to grant unto the said C. William Siemens, his heirs, or assigns, for the term of seventeen years from the twenty-seventh day of April, one thousand eight hundred and sixty-nine, the exclusive right to make, use, and vend the said invention throughout the United States and the Territories thereof.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the city of Washington, this twenty-eighth day of August, in the year of our Lord one thousand eight hundred and seventy-seven, and of the Independence of the United States of America the one hundred and second.

[L. S.] A. BELL,
Acting Secretary of the Interior.

Countersigned:
ELLIS SPEAR,
Commissioner of Patents.

284 UNITED STATES PATENT OFFICE.

C. WILLIAM SIEMENS, of Westminster England.

Improvement in Valves for Regenerator Furnaces.

Specification forming part of letters patent No. 89441, dated April 27, 1869; reissue No. 7864, dated August 28, 1877; application filed December 5, 1876.

Division C.

To all whom it may concern:

Be it known that I, Charles William Siemens, of Westminster county of Middlesex, England, have invented certain improvements in the arrangement and construction of valves for distributing and regulating the currents of air and gas in regenerative gas furnaces.

The following description taken in connection with the accompanying drawings hereinafter referred to, forms a full and exact specification, wherein are set forth the nature and principles of the invention by which the same may be distinguished from others for which letters patent have heretofore been granted, together with such part thereof as I claim as new, and desire to secure by reissued letters patent of the United States.

My invention relates to that class of furnaces known as regenerative gas furnaces, for which letters patent of the United States were granted on the first day of March, 1864; and the nature thereof consists in an improved arrangement of the valves for distributing and regulating the currents of air and gas.

In the accompanying plate of drawings Fig. 1 is a longitudinal section of the furnace. Fig. 2 is a transverse section; Fig. 3 rear elevation of the furnace and a section through the gas passages. Fig. 4 is a front elevation. Fig. 5 is a sectional plan.

The regenerative gas furnace, as shown in the drawings, is built of fire-brick, or other suitable refractory material, and con-
285 sists of the four regenerators with their flues and valves and the heating chamber where the metallurgical operations are carried on.

The four regenerators are arranged in pairs and vary in size, the smaller being used for the passage of gas and the larger for that of air. The walls of the regenerators are built of fire-brick or other suitable refractory material closely laid and made gas-tight, so that no leakage may take place from one chamber to another. These chambers are filled with refractory material, by preference fire-brick stacked loosely together, and each regenerative chamber has its own separate flue at the base, communicating with the values by which the gas and air enter or products of combustion pass out, while from the top and each side of each regenerative chamber a series of flues lead upward and communicate with the heating chamber.

The entering or issuing gaseous currents pass through valves X, one for gas and the other for air. The gas-valve is in communication with the gas-box V. Each valve consists of three parts viz., a central piece, Y, and two side boxes, Z, Z, which are usually made of cast iron, and by preference in three distinct pieces, which may be afterward suitably fastened together. In the central part Y is the reversing flap T, which may be centered about a spindle and moved by levers as shown. This flap is made to fit as exactly as possible, so that no leakage from one side of it to the other may take place. By its means the direction of the currents of gas or air, or of the escaping products of combustion, are completely under control. Upon each side of this central part are the side boxes Z Z, which are set upon the brick work of the flues, of which they virtually form a part.

In passing through the side boxes, which I prefer to expose to cooling influences, the gaseous currents themselves become cooled, and thus the reversing flap is preserved from overheating and consequent warping. Each side box is fitted with a cover, Z', carefully luted on, which is used for cleaning purposes. Above the reversing-flap is the throttle-valve W through which air or gas is admitted to their respective flues. I prefer to make this circular in form, in the shape of an inverted mushroom, with the edges which fit the seat turned to the segment of a sphere, so that when necessary it may be shut down tight upon its seat.

The gas throttle-valve may be placed inside a gas box of
286 cast or wrought iron, into which the gas from the main flue may be led by a conduit of similar material, as shown. In the gas box and above the throttle valve may be fitted or luted on a movable cover, V, through which the interior may be reached for cleaning purposes.

On first lighting the furnace the gas passes through the said valves and flues into the bottom of the regenerator chamber C, while the air enters through corresponding valves and flues into the regenerator chamber E. The currents of gas and air, both comparatively cold, rise separately through the regenerators C and E, and pass up

through the flues, or series of flues, G G G and F F F F, respectively, into the furnace above, where they meet and are lighted, burning and producing a moderate heat. The products of combustion pass away through a similar set of flues at the other end of the furnace into the regenerator chambers C′ E′, and thence, through properly-constructed flues and valves, to the chimney flue. The waste heat is thus deposited in the upper courses of open fire-brick work, filling the chambers C′ E′ and heating them up, while the lower portion and chimney flue are comparatively cool. Then, after a suitable interval, the reversing-flaps T, through which the air and gas are admitted to or withdrawn from the furnace, are reversed, and the air and gas enter through those regenerator chambers E′ C′, which have just been heated by the waste products of combustion, and, in passing up through the checker-work, they become heated, and then, on meeting and entering into combustion in the furnace D, they produce a very high temperature, the waste heat from such higher temperature of combustion heating up the previously cold regenerators C E to a corresponding higher heat. Thus an accumulation of heat and an accession of temperature are obtained step by step, so to speak, until the furnace is as hot as is required. The heat is at the same time so thoroughly abstracted from the products of combustion by the regenerators that the chimney flue remains comparatively cool.

The command of the temperature of the furnace and of the quality of the flame is rendered complete by means of gas and air regulating valves and by the chimney damper, as above described.

Having thus described my invention, I claim and desire to secure by letters patent of the United States—

287 1. In a regenerative gas furnace, the reversing valve, provided with metallic side boxes, substantially as shown and described.

2. In combination with the reversing valve and side boxes, the mushroom throttle-valve, substantially as herein described.

In testimony that I claim the foregoing I have hereunto set my hand, this 11th day of September, 1876.

C. WILLIAM SIEMENS.

Witnesses:
W. W. ANTHONY,
THOMAS ROBINSON,
Clerks to Ridgway Bros., 2 Waterloo Place, Pall Mall, London.

(Here follows diagrams, marked pp. 288, 289, 290, & 291.)

292 And afterwards, to wit, on the 8th day of May, A. D. 1883, this cause came on for hearing on pleadings and proofs, and being argued by the counsel for the respective parties, the court held the same under advisement.

And afterwards, to wit, on the 14th day of May, A. D. 1883, the opinion of the court was filed by Hon. William Butler, judge, in the words following, to wit:

4 Sheets—Sheet 1.

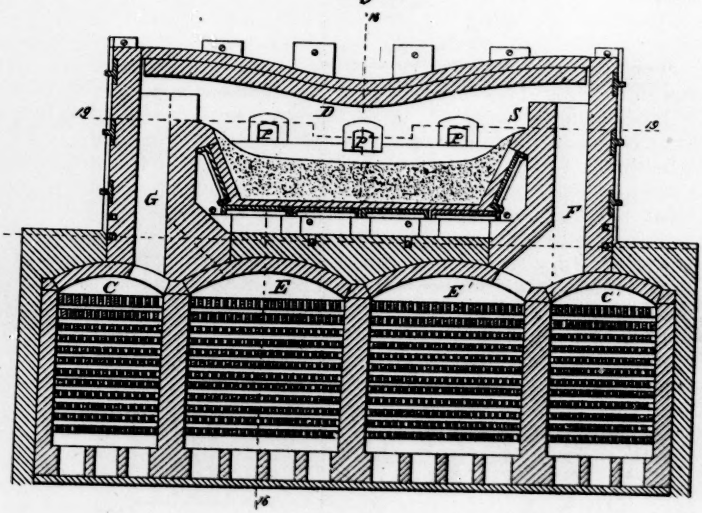
C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,864. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs.
Sellers et al.
} b. 288.

Fig. 1.



Witnesses.
Joseph B. Wildman
W. J. Whitehouse

Inventor.
Charles William Siemens
by Charles S. Whitman
attorney

4 Sheets—Sheet 2.

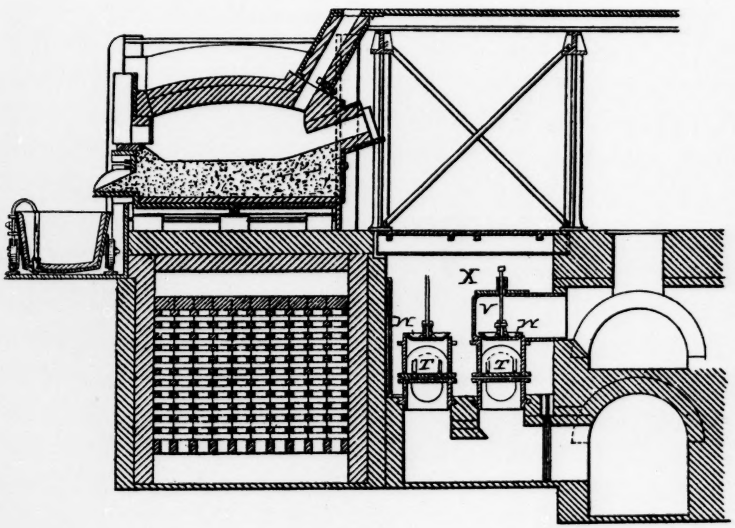
C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,864. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs
Sellers et al.
p. 289

Fig. 2



Witnesses.
A. L. Wildman
W. J. Hutchinson

Inventor.
Charles William Siemens
by Charles S. Whitman
Attorney

4 Sheets—Sheet 3.

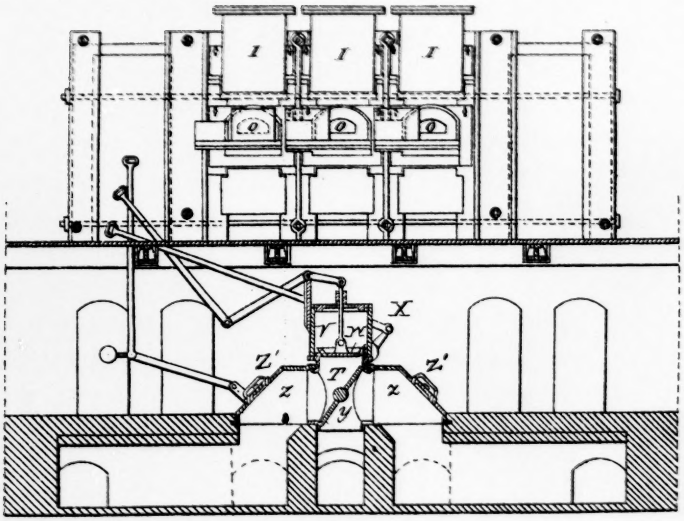
C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,864. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs
Sellers et al.
} p. 290

Fig. 3.



Witnesses.
Joseph C. Wildman
W. F. Hutchinson

Inventor.
Charles William Siemens
by Charles S. Whitman
attorney

4 Sheets—Sheet 4.

C. W. SIEMENS.

REGENERATOR-FURNACES.

No. 7,864. Reissued Aug. 28, 1877.

No. 297.
Siemens et al.
vs.
Sellers et al.
p. 291

Fig. 4

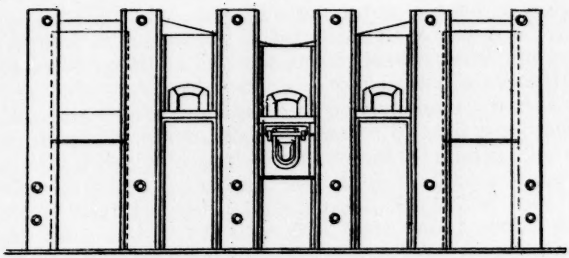
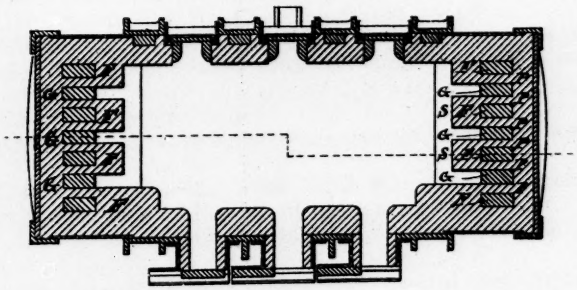


Fig. 5.



Witnesses.

Joseph C. Hildman
W. T. Hutchinson

Inventor.

Charles William Siemens
by Charles S. Whitman
attorney

BUTLER, *J.:*

293 On the first of March, 1864, the complainants obtained letters patent from the United States for "Improved Regenerator Furnace, for Metallurgists and others," and on the 12th of January, 1869, procured a reissue of the same.

The bill, after reciting these facts and making the usual averments, charges the respondents with infringement of their rights under the patent.

The answer, admitting the grant of letters as claimed, denies that the respondents, or either of them, have "made, used, or sold furnaces embracing in their construction or mode of operation, substantially the invention patented by said letters," says, they "believe the Midvale Steel Works, a corporation organized under the laws of Pennsylvania, doing business at Philadelphia, has since July 22d, 1878, used a furnace embracing substantially the construction and mode of operation specified and claimed in said letters," and admits that they "have been directors of said corporation since July 22d, 1868," but says they "are informed and believe that such use by said corporation, even if it constituted a violation by said corporation of the complainant's rights in said letters, is not a violation for which they or either of them are in any way liable." The answer then proceeds to aver that English letters patent, No. 167 of 1861, dated January 22d, 1861, and sealed July 19th, 1861, were granted to the complainants for "Improvements in Furnaces," and that said invention thus patented is substantially the same as that for which letters were granted by the United States, and here sued upon; and that the said last-named letters patent are, consequently, limited to a term of seventeen years from the date or publication of the English letter; and that the letters sued upon, therefore, expired on or before July 22d, 1878, and before the alleged infringement complained of.

The defence thus presented is two-fold, first, that the alleged infringement did not occur until after the expiration of the patent; second, that the defendants, as here sued, are not responsible; and involves the following questions:

First. Are the English and American patents for the same invention?

Second. If they are, is the latter limited to a term of seventeen years from the date or publication of the former?

Third. Are the respondents personally responsible for the acts of steel company?

As respects the first of these questions, a careful examination of the specifications and drawings, after full consideration of the elaborate and able argument of complainants' counsel, has satisfied me that the inventions embraced in the patents are substantially identical. In construction and mode of operation they seem, in all essential respects, to be the same. I cannot doubt that had any one here manufactured or used a regenerator furnace for metallurgical purposes since the date of the American patent and before its expiration, constructed in the most precise accordance with the English

patent, or had there, during the term of the latter, manufactured or used such a furnace, constructed in accordance with the American patent, he would speedily have been charged with infringement and held responsible in damages. To enter upon a comparison of the specifications and drawings of the two patents, and an analysis of the testimony relating to the subject, would be a useless expenditure of time. Aside from the testimony of the witnesses, it seems impossible to read the specifications and compare the drawings side by side, and avoid the conclusion stated; and the testimony of the witnesses tends in the same direction, adding strength to the conclusion. Indeed, except as respects literal description of the apparatus, there is scarcely a shade of difference between the description of the invention here and abroad—when the drawings and specifications are considered together. Not a thought is expressed in the American patent that is not to be found in its English predecessor. Every claim of the former may as readily be sustained by reference to the specifications and drawings of the one as the
294 other. The principal differences sougth to be established by the complainants are—

First. That the American patent provides for a more perfect mixture of the air and gas by introducing the air into the "mixing chamber," behind or above the gas instead of in front.

Second. That it contains regulating valves in the air and gas chambers, or channels.

Third. That it contains a different provision for the introduction and circulation of air under the bed of the furnace.

These differences, however, I do not find except to such immaterial extent as renders them unimportant. No reference is made in the American patent, or any paper accompanying it, to the materiality of introducing the air behind or above the gas, and it is quite plain that no importance was, at the time, attributed to it. If advantageous, the fact was undiscovered. The patent was not confined to such an arrangement of the air and gas passages. If reversed, the claims would have covered it. The circumstances justify the belief that the arrangement, in this respect, shown in the American drawings, was virtually accidental and considered immaterial. In the English patent the drawings for the glass furnace show the passages reversed—the gas entering behind—while in the puddling furnace the arrangement is still different, and in neither patent nor in any paper connected with it is there a suggestion that the particular arrangement shown is of any consequence. I cannot doubt that the English patent covered the arrangement shown in the American drawings. At a later date C. W. Siemens, one of the complainants, discovered that the method of introducing air and gas might be improved, and, in 1877, obtained a patent in this country for this improvement. Still, however, no suggestion is made respecting the importance of introducing the air back of or above the gas, or of the manner of cnnducting the air and gas into the "mixing chamber." The improvement consisted substantially in keeping the two fluids separated, and thus avoiding combustion, until the point is reached at which heat is required.

As respects the regulating valves shown in the air and gas channels of the American drawings, they are certainly embraced in the English patent. While the drawings there do not exhibit them, they are called for in the specifications, which say: "Dampers are provided for in the air and gas channels, by which the quantity and quality of the flame can be regulated to the utmost nicety;" and, again: "The currents of heated air and gas, in ascending from and through the regenerators into the furnace, cause a plenum of pressure within the same, which is capable of being modified or regulated by valves for the admission of air and gas to the regenerators and by the chimney damper. By the same arrangement the chemical qualities, as well as the intensity of the flame, can be regulated to the utmost nicety." That the English drawings do not show these regulating valves is unimportant. A competent builder would know where to place them.

The same must be said respecting the provision for introducing and keeping up a supply of air to the bed of the furnace. The English patent shows substantially the same thing. The open chamber, lettered C in the American drawings and patent, is distinctly shown in the English patent, there lettered *a*, and its purpose and value are there set out substantially as here—the protection of the bottom or hearth, and the crown of the arches below, by providing for the passage of a sufficient quantity of cool air through the space *a*, to prevent the cumulative action of the heat, which, in long continued use of the furnace, would end in its destruction.

295 The statement of complainants' experts that a furnace fit for actual use in metallurgical operations could not be made from the English specifications does not seem entitled to much weight. If true it would serve as well for condemnation of the American patent as the English. It is opposed, however, by other important testimony, and also by the emphatic assertion of the complainants themselves in taking out the English patent.

Having ascertained the patents to be for the same invention the second question stated becomes important: Did the American patent expire before the occurrence of the alleged infringement—in other words, at the expiration of seventeen years from the date or publication of the English patent? This involves a construction of the patent laws of the United States at the date of complainants' letters. The language of the act of 1861, that "all patents hereafter granted shall remain in force for seventeen years from the date of issue," and "all acts and parts of acts heretofore passed which are inconsistent with this act are hereby repealed," considered in connection with former and existing legislation respecting inventions first patented abroad, was well calculated to create the doubt and embarrassment which have followed. In the absence of decision by other courts, I believe I would have reached the conclusion that the language first quoted was intended simply to increase the duration of all patents thereafter issued, equally—giving to each an additional period of three years—without interfering with the distinction so long maintained between inventions originally patented here and

those first patented abroad. The question, however, having been fully considered by Judge Blatchford in a case requiring its decision, De Floray *v.* Reynolds, 17 Blatch., 436, I am content to adopt his views without entering upon the discussion. The reasons on which he rests his conclusions commend themselves to my judgment. In Weston *v.* White, 13 Blatch., 364, the question was decided in the same way. Its decision, however, was not actually necessary, and was made without discussion. In Goff *v.* Stafford, 14 Off. Gaz., 748, Judge Clifford held otherwise. Here again, however, as in Weston *v.* White, the question was not directly involved, and was but slightly considered.

It would be unprofitable to go further. What has been said disposes of the case.

The bill must be dismissed, with costs.

296 And afterwards, to wit, on the 16th day of May, A. D. 1883, the court enter- the following decree, to wit:

United States Circuit Court, Eastern District of Pennsylvania. In Equity. Oct. Sess., 1880.

CHARLES WILLIAM SIEMENS AND FREDERICK SIEMENS *vs.* WILLIAM SELLERS *et al.* } No. 8.

This cause having been set down for final hearing at the April term of this court, A. D. 1883, and having been then fully heard upon the pleadings and proofs herein, before the Honorable William Butler, district judge, sitting and holding this circuit court, and due deliberation being had theron, the opinion of the court is filed, and it is thereupon, this 16th day of May, A. D. 1883, ordered, adjudged, and decreed that the bill of complaint in this cause be, and the same is hereby, dismissed.

And it is further ordered, adjudged, and decreed that the defendants do recover of the complainants their costs, charges, and disbursements in this cause, to be taxed by the clerk of this court.

297 And afterwards, to wit, on the 8th day of June, A. D. 1883, the complainants, by their counsel, came into our said court here and pray an appeal to the Supreme Court of the United States, and the same is allowed in the words following, to wit:

C. C. U. S. Oct. Sess., 1880. In Equity.

SIEMENS *vs.* SELLERS. } No. 8.

And now, to wit, June 8th, 1883, Messrs. Pettit and Whitman, solicitors for complainants, appear in open court and pray an appeal to the Supreme Court of the United States from the decree dismissing their bill, with costs, entered May 16th, 1883, and the same is allowed, security to be entered in the sum of five hundred dollars.

298 In the Circuit Court of the United States in and for the Eastern District of Pennsylvania, in the Third Circuit. October Sess., 1880.

CHARLES WILLIAM SIEMENS and FREDERICK SIEMENS,
vs.
WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, Jr., JOSEPH F. TOBIAS, and JAMES A. WRIGHT. } No. 8.

Know all men by these presents that we, Charles William Siemens and Frederick Siemens as principals, and Henry B. Richmond, No. 1402, Spruce St., Philadelphia, Penna., and Henry A. Brognard, No. 2143 North 12th St., Philadelphia, Penn., are held and firmly bound unto the above-named William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright in the sum of five hundred dollars ($500) to be paid to the said William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright, their certain attorney, executors, administrators, or assigns, to which payment, well and truly to be made, we bind ourselves, our respective heirs, executors, and administrators, jointly and severally, by these presents.

Sealed with our seals, and dated this 13th day of July, A. D. 1883.

Whereas lately, at a circuit court of the United States, in and for the eastern district of Pennsylvania, in the third circuit, it a suit pending in said court between Charles William Siemens and Frederick Siemens, complainants, and William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright, defendants, a final decree was rendered against the said Charles William Siemens and Frederick Siemens, and the said Charles William Siemens and Frederick Siemens having taken an appeal, which appeal has been allowed by the said circuit court to the Supreme Court of the United States to reverse the said decree in the aforesaid suit.

299 Now the condition of the above obligation is such, that if the said William Siemens and Frederick Siemens shall prosecute their said appeal to effect, and answer all damages and costs if they fail to make their appeal good, then this obligation to be null and void; otherwise to remain in full force andvirtue.

CHARLES W. SIEMENS. [L. S.]
FREDERICK SIEMENS. [L. S.]
Per HENRY B. RICHMOND,
Attorney-in-fact.

HENRY B. RICHMOND. [L. S.]
HENRY A. BROGNARD. ["]

Sealed and delivered in the presence of—
SAMUEL BELL.
W. VON A. WILLIAMSON.

Sureties approved.
WM. BUTLER, *J.*

[Endorsed:] No. 8. October sess., 1880. Circuit court United States. Siemens *et al. vs.* Sellers *et al.* Bond *sur* appeal. Filed July 13, 1883.

300 THE UNITED STATES OF AMERICA, *ss:*

To William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright, Greeting:

You are hereby cited and admonished to be and appear at a Supreme Court of the United States, to be holden at Washington, on second Monday of October next, pursuant to an appeal filed in the clerk's office of the circuit court of the United States, for the eastern district of Pennsylvania in the third circuit, wherein Charles William Siemens and Frederick Siemens are appellants, and you are appellees, to show cause, if any there be, why the decree rendered against said appellants, as in said appeal mentioned, shall not be corrected, and why speedy justice should not be done to the parties in that behalf.

Witness my hand, this 13th day of July, in the year of our Lord one thousand eight hundred and eighty-three.

WM. BUTLER, *Judge.*

Service accepted, July 26th, 1883.

HENRY BALDWIN, JR.

301 UNITED STATES OF AMERICA, *Eastern District of Pennsylvania,* } *ss:*

I, Samuel Bell, clerk, do hereby certify the foregoing to be a true and faithful copy of the record and proceedings of the circuit court of the United States, in and for the eastern district of Pennsylvania in the third circuit, in a certain cause therein lately depending between Charles William Siemens and Frederick Siemens, complainants, and William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright, defendants.

In testimony whereof I have hereunto subscribed my name and affixed the seal of the said circuit court of Philadelphia, this eighteenth day of September, A. D. 1883, and in the 108th year of the Independence of the said United States.

[Seal U. S. Circuit Court, E. D. Pennsylvania.]

SAMUEL BELL,
Clerk Circuit Court U. S.

Endorsed on cover: E. Pennsylvania, C. C. U. S. No. 297. Charles William Siemens and Frederick Siemens, appellants, *vs.* William Sellers, Edward W. Clark, John Sellers, Jr., Joseph F. Tobias, and James A. Wright. Filed 24th September, 1883.

123-246

Office Supreme Court U. S.
FILED.
OCT 1 1887
JAMES. H. McKENNEY.
CLERK.

Supreme Court of the United States.

No. 6.—October Term of 1887.

CHARLES WILLIAM SIEMENS (entitled Sir WILLIAM SIEMENS, Knight,) and FREDERICK SIEMENS, Appellants,

vs.

WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, Jr., JOSEPH F. TOBIAS, and JAMES A. WRIGHT.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE EASTERN DISTRICT OF PENNSYLVANIA.

BRIEF FOR APPELLANTS.

CHARLES S. WHITMAN,
Solicitor and of Counsel for Appellants.

Press of Thomas McGill & Co., Washington, D. C.

Supreme Court of the United States.

OCTOBER TERM 1887.—No. 6.

CHARLES WILLIAM SIEMENS (ENTITLED SIR WILLIAM SIEMENS, KNIGHT,) AND FREDERICK SIEMENS

vs.

WILLIAM SELLERS, EDWARD W. CLARK, JOHN SELLERS, JR., JOSEPH F. TOBIAS, AND JAMES A. WRIGHT.

BRIEF FOR APPELLANTS.

STATEMENT OF THE CASE.

This is an appeal from the decree in Equity of the Circuit Court of the United States for the Eastern District of Pennsylvania, dismissing the bill of the appellants, who were the complainants in that Court.

The case is a suit upon Reissued Letters Patent, dated January 12, 1869, for "Improved Regenerator Furnace for metallurgists and others," granted to the complainants.

The bill of complaint is in the usual form of such bills, and alleges that Charles William Siemens and Frederick Siemens were the original and first inventors of the invention patented, the grant of the original Patent on the first day of March, 1864, and the subse-

quent Reissue of the same on the twelfth day of January, 1869. It also charges that the defendants have infringed the invention patented, and prays, in the customary form, for an injunction and account of profits.

The answer denies that the defendants, or either of them, have infringed, but admits that the Midvale Steel Works has, since July 22d, 1878, "used a furnace embodying substantially the construction and mode of operation specified and claimed in said Reissued Patent," and that the defendants "have been directors of the said corporation since July 22d, 1878." It also avers that English Letters Patent, No. 167, of 1861, dated January 22d, 1861, and sealed July 19, 1861, were granted to Charles William Siemens and Frederick Siemens, the above-named complainants, for "improvements in furnaces;" that the said invention so patented by said Letters Patent, is substantially the same invention patented in the Reissued Letters Patent aforesaid, and that the said Reissued Letters Patent expired on or before the twenty-second day of July, 1878. It also avers that the subject-matter specified and claimed in the third claim of said Reissued Letters Patent is not lawfully patentable under the law of the United States. It also avers that said Reissued Letters Patent are null and void, because they purport to be granted for the term of seventeen years from March 1st, 1864, and are not expressly limited to a term of seventeen years from the date or publication of the aforesaid English Letters Patent. It also denies that the making, using, or vending, since July 22d, 1878, of a furnace embracing in its construction or mode of operation the invention patented in the said Reissued Letters Patent is an infringement of any right of the complainants. It also denies that the Midvale Steel Works has, or that the defendants or either of them have, since the first day of July, 1878, and before the twenty-second day of July, 1878,

made, used, or sold a furnace embracing in its construction or operation the invention patented in the said Reissued Letters Patent.

The evidence introduced by the complainants consists of the Reissued Letters Patent marked "Exhibit, Complainants' Reissued Letters Patent No. 3265," and printed on page 69 of the record, and the depositions of George R. Waite and Park Benjamin, witnesses on behalf of complainants, in rebuttal, and the English Patent of Frederick Siemens, printed on page 75 of the record.

The evidence of the defendants consists of exhibits, "Complainants' Reissued Letters Patent No. 3265," "Complainants' Original American Patent," "Complainants' Application for Original American Patent," and "Complainants' English Patent of 1861," and the depositions of Coleman Sellers and Theodore Bergner.

The cause having been set down for hearing at the April Term of the Court, A. D. 1883, and having been heard on the pleadings and proof before the Honorable William Butler, District Judge, holding the Circuit Court, the opinion of the Court was filed, (Record, p. 193,) and a decree was entered dismissing the bill of complaint. (Record, p. 196).

The question involved may be stated as follows:

1. Was the invention claimed in the Reissued Letters Patent granted to the complainants, upon which this suit is brought, "patented in a foreign country more than six months prior to their application in this country?"

2. If it is held that the invention for which the complainants have been granted Letters Patent of the United States was not "patented in a foreign country more than six months prior to their application" in the United States, the question as to what is the legal term

of a United States Patent for an invention first patented in a foreign country need not be considered; but if, on the contrary, it should appear that the invention claimed was so patented, *it will be necessary to consider the legal term of a Patent taken out in this country prior to the Act of 1870, and subsequent to the Act of 1861, when the patentee had patented his invention abroad more than six months prior to his application*, and to consider generally the statutes by which the terms of United States Patents are regulated, and the effect of the provision of Sections 16 and 17 of the Act of 1861, upon the provision of Section 6 of the Act of 1839.

3. The question as to whether the defendants, as directors of the Midvale Steel Works, are liable and accountable for the infringement by the latter of the Patent of the complainants was not referred to by the Court below in its opinion or decree.

These questions will be considered in the order that they have been stated.

The state of the art at the date of the Patent is fully disclosed in the standard and leading work on the Metallurgy of Iron, page 684, by John Percy, published in London by Murray, 1864.

Specification of Errors.

1. The Court below erred in not considering the state of the art as shown by the English Patent of Frederick Siemens, No. 2861 of 1856, in determining the scope of the English Patent of C. W. and F. Siemens of 1861, and the United States Patent, No. 3265.

2. It erred in construing the United States Patent, No. 3265, in not considering the drawings as a part of the specification thereof, and limiting the claims to the invention shown in the drawings and accompanying description.

3. It erred in ruling that a person skilled in the art would be able, from the specification and drawings of the English Patent, No. 167 of 1861, to make and use the invention in the absence of proof that such invention had ever been used, and in misunderstanding, misconstruing, and ignoring the evidence upon this subject.

4. It erred in holding that it was necessary to advertise in the specification the advantages obtained by a described combination of parts in order to sustain a patent for it.

5. It erred in holding that the regulating valves described and claimed in the United States Patent of C. W. and F. Siemens, No. 3265, are shown in the English Patent, No. 167, of 1861, in the absence of any drawing or description of such valves in the English Patent.

6. It erred in holding that the provision for keeping up a supply of air to the bed of the furnace, as described in United States Patent, No. 3265, is shown in English Patent, No. 167, of 1861, and in misunderstanding, misconstruing, and ignoring the evidence upon this subject.

7. It erred in holding that the statement of complainants' experts, that a furnace fit for actual use in metallurgical operations could not be made from the English specification, would serve as well for the condemnation of the American Patent as the English.

8. It erred in holding that all the inventions embraced in the United States Patent, No. 3265, and the English Patent, No. 167, of 1861, are identical, and that in construction and mode of operation they are substantially the same.

9. It erred in holding that no reference is made in the American Patent, or any paper accompanying it, to the materiality of introducing the air behind the gas.

10. It erred in holding that the introduction of the air behind the gas was undiscovered by the complainants when the United States Patent was taken out.

11. It erred in holding that the arrangement for introducing the air behind and above the gas, shown in the American Patent, was accidental and considered immaterial.

12. It erred in not holding that, as the invention claimed in the United States Patent was not claimed in the English Patent, it was not patented therein.

13. It erred in not holding that the invention *claimed* in the one claim of the English Patent was for a different invention than those claimed in the first three claims of the American Patent.

14. It erred in holding that the term of the United States Patent upon which the suit is brought is limited to seventeen years from the date of the publication of the English Patent of C. W. and F. Siemens.

15. It erred in holding that no suggestion is made in the Patent of C. W. Siemens respecting the importance of introducing the air above the gas.

16. It erred in not limiting the claims of the United States Patent to the exact invention described in the specification and shown in the drawings.

17. It erred in not holding that in order to limit the term of the United States Patent the invention claimed in the English Patent should be substantially the same as the invention claimed in the United States Patent.

FIRST.

THE INVENTION CLAIMED IN THE COMPLAINANTS' REISSUED LETTERS-PATENT WAS NOT "PATENTED IN A FOREIGN COUNTRY MORE THAN SIX MONTHS PRIOR TO THE APPLICATION," BECAUSE—

1. It is not claimed in the English Letters-Patent, No. 167, of 1861.

2. It is not described in the said English Patent in such full, clear and exact terms as to enable any person skilled in the art or science to which it appertains to make, construct and practice the invention patented.

A comparison of the Reissue with the English Patent, which has been set up in the answer, discloses many features of construction in the furnace described in the former which are not shown and described in the latter. The principal points of difference are as follows:

First. In the English Patent, No. 167, the air for cooling the bed of the furnace is *drawn downward* through the passages and into a chamber, *and from thence to the air regenerator*, whereas in the Reissue, No. 3265, the air passes *upward from a cooling chamber through the chimneys*, the tops of which are clearly shown in plan in Fig. 1, and by dotted lines in Figs. 2 and 3.

Second. In the Reissue, there is a cooling chamber beneath the bed of the furnace, *all the parts of which communicate with each other in such a manner as to allow the air to pass freely* about and around the under side of the furnace bed; whereas in the English Patent a number of small separate passages are shown below the bed of the furnace, through which the air *is drawn downward into the regenerator.*

Third. In the United States Reissue, the gas regenerative chambers are arranged in the space between the air regenerative chambers, whereas in the English

Patent, No. 167, the gas regenerative chambers are arranged on the outside of the air regenerative chambers.

Fourth. In the Reissue, the gas rises into the mixing chamber *in front of the air, and between the air-flue and the point where metallurgical and other operations are conducted* in the furnace, whereas in the English Patent no such construction is shown.

Fifth. The damper chests in the English Patent, No. 167, are rectangular in section, while the damper chests in the Reissue are circular.

Sixth. In the United States Reissue, the partition walls between the air and gas regenerators *extend vertically upward, and form the division walls between the air and gas flues.* No such construction is shown in English Patent, No. 167.

Seventh. The partition walls between the regenerative chambers and the partition walls separating the air and gas flues *are in the same vertical plane* in the United States Reissue. No such construction is shown in the English Patent, No. 167.

Eighth. In the American Reissue there is a space, "E," arranged immediately below, and communicating with a space, "D," but there is no such construction shown in the English Patent, No. 167.

Ninth. In the Reissue the air enters the combustion chamber behind the gas, which is not the case in English Patent, No. 167.

Tenth. In the furnace for manufacturing iron described in the English Patent, No. 167, *the currents of gas and air oppose each other* upon entering the combustion chamber and meet, coming in opposite directions, but this is not the case in the Reissue.

Thus far the difference in construction enumerated is admitted by Mr. Sellers, and also by Mr. Bergner, the expert of the defendants. (Record, p. 91 to 101 and 110 to 119.)

Eleventh. In the English Patent, No. 167, no means are provided for supplying an adequate supply of air to support combustion, whereas in the Reissue the supply is adequate.

Twelfth. In the English Patent, No. 167, there is no means of regulating the amount of air and gas admitted to the furnace, whereas in the Reissue the air and gas supply may be regulated with precision and accuracy.

Thirteenth. In the English Patent, No. 167, there is an imperfect mixture of the air and gas in the combustion chamber, whereas in the Reissue a perfect admixture of the air and gas takes place, *owing to the fact that the air enters the combustion chamber above the gas*, and thus by its superior specific gravity at equal temperatures sinks through the gas.

Having thus pointed out the principal improvements in the construction of regenerative furnace as shown and described in the Reissue, we proceed to call attention to the advantages and new and useful results which these improvements and novel combinations effect.

These new and useful results may be classified as follows:

1. An adequate supply of air in the combustion chamber.

2. A perfect admixture of the air and gas in the combustion chamber.

3. An accurate regulation of the amount of air and gas admitted to the regenerators and combustion chamber, insuring a command of the quantity as well as quality of the heat.

4. The proper cooling of the bed of the furnace and arches of the regenerators.

5. A uniform distribution of the weight carried by the regenerator arches.

Adequacy of the Supply of Air to the Combustion Chamber.

In the English Patent, No. 167, the construction by means of which the outer air is made to reach the combustion chamber, is illustrated in Figures 1 and 3, Sheet 1, and described in the following language in the specification:

"In order to prevent the accumulation of excessive heat in the arch covering the regenerators, and forming at the same time the support of the furnace bed, we provide chambers between the same for the circulation of atmospheric air." (Record 160, line 4.)

"These regenerators are arched over at the top, and support the bed *a* of the furnace. This consists of a number of slabs of fire clay or other refractory material, having on the under side *small channels*, *e*, *e*, *e*, communicating at one end through the channel *f*, with the atmosphere, and at the other end with the *passage* I, *conducting to the regenerators.* A current of cold air is continually passing through these channels, tending to maintain the bed of the furnace and the arches covering the regenerators at a low temperature." (Record, page 161, line 35.)

This language is clear, specific and unambiguous, and from it we learn that the scheme of the inventors was to draw the air to support combustion through the channels *e*, *e*, *e* into the "air passage conducting to the regenerators." In order to effect this result it would be necessary to close the top of passage I from the outer air, and accordingly we find it represented as closed at the top in Figure 3, Sheet 1, of the drawings.

Mr. Sellers, one of defendants' experts, admits this, as will be seen from his testimony upon cross-examination. (Record, pages 91 and 92, x-q. 7 to 13.)

The same admission is made by the defendants' expert, Mr. Bergner. (Record, page 111, x-q. 9, 10.)

That the supply of air would be inadequate in a furnace of this construction is practically admitted by the

defendants' expert, Mr. Sellers. (Record, pages 101 and 102, x-q. 43.)

It will be noticed that Mr. Sellers infers "that some other opening, not shown in the drawing, for the admission of air into I, would be necessary in the successful working of the furnace as shown." He does not state, however, that he believes that it was intended by the inventors that "some other opening should be used."

Mr. Waite, a furnace builder of many years' experience, testifies that a furnace constructed according to the specification and drawing of English patent, No. 167, would not be capable of use, on account of "an inadequate supply of air supplied for combustion," (Record, page 10, Q. 10), and upon being cross-examined by the counsel for the defendants, so testifies. (Complainants' Record, pages 21 to 24, x-qq. 107–112, 118, 119, 128–134.)

In describing Figure 11, Sheet 2, the following language is used in the specification of the English Patent, No. 167, (Record, p. 165):

"Below the bed, spaces *a*, *a*, *a*, are provided for the circulation of cold air. Beneath the furnace are the regenerators C^1, C^2, C^3, C^4, constructed in a similar manner to those already described," but the specification is entirely silent as to how the air is introduced into the space *a*, *a*, *a*, or how it is withdrawn, and it is obvious that a person skilled in the art could not, from this description, construct a furnace capable of actual use.

As, however, it may be argued that the description used in reference to Figure 3, Sheet 1, was intended to apply to all the other figures to which it is applicable, it becomes necessary to consider what effect would be produced by enlarging the channels *e*, Figure 3.

It must be evident, if we take into consideration what is now known of the state of the art, that such an enlargement would cause a rush of cold air through the

passages which would chill the bottom of the furnace, as is stated by Mr. Waite in his testimony above quoted, and that the cooling of the bed of the furnace would not be uniform and regular, but dependent upon the amount of air used in the combustion chamber of the furnace. This would, of course, render it impossible to furnish an adequate supply of air to the combustion chamber, as in so doing the furnace would be rendered inoperative. (Record, page 43.)

In the Reissue all these objections are obviated, and an adequate supply of air for the combustion chamber is drawn directly from the outer air through an air space. This air space is described in the specification as follows (Record, page 73, line 41):

"In the rear of the upper parts of the regenerators, and below the furnace, there is an air space or chamber D, which, at intervals, is bridged, as shown at *g*, *g*, *g*."

The third claim in which this air space is designated is as follows (Record, p. 74):

"We also claim the arrangement and combination of the air-chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified."

The damper chests mentioned in this claim are thus described in the specification (Complainants' Record, page 74, line 7):

"Between the two passages I K there is a smoke-flue, P, into the rear of which there is an opening Q′, leading from the passage F, or a damper case R, arranged vertically therein, and having a damper, S′, arranged within it, and so as to be capable of being turned by a lever, *h*. There is another such damper case, T′, applied in the passage N, and opening at its opposite sides into such passage, and also at its top into the generator conduit or gas-flue, O′. Within the case T′ there is a damper, U,

capable of being turned by a lever, *i*. Situated over each of the damper cases there is a valve opening, V′ or W′, provided with a valve, X or Y, the whole being arranged as shown in Figs. 3 and 4.

"By means of the damper U, gas from the passage O may be led into either of the passages I K, it being cut off from passing into one while it may be passing into the other; so, by means of the damper S′, air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other. The valve Y will serve to arrest the flowage of air into the passage F; so, with the valve X it will answer to close off the passage of gas into the damper case immediately underneath it."

It therefore appears that in English Patent, No. 167, no means is described for supplying an adequate amount of air to the combustion chamber, but that in the Reissue an adequate supply is drawn from the outer air, and accurately regulated by the damper chests.

It also appears that the devices by which this result is obtained are fully described and claimed.

A perfect admixture of the air and gas in the combustion chamber.

In the specification of the Reissue the inventors say :

"The object of our invention is not only to economize heat, or to save and utilize much of it that is generally wasted by being allowed to escape into and through the chimney of the furnace, *but to produce heat by the combustion of gases and atmospheric air in mixture.*" (Record, p. 70, line 12.)

In describing how "the combustion of gases and atmospheric air and mixture" is produced in the furnace, they use the following language :

"Passages lead from the upper part of these regenerators into the furnace or into a *channel or passage communicating with one end thereof;* similar passages lead from the two remaining regenerators, and in a

similar manner communicate with the opposite ends of the furnace." (Record, p. 70, line 26.) "After ascending through their regenerators, or between the bricks of the mass of loosely-piled brick-work or other refractory material making part of such regenerators, the said aerial and gaseous currents unite and flow into the furnace, where they are to be fired." (Record, p. 70, line 44.) "Each of the said regenerators is arched or closed over at its top, and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or *f'*, *as shown in the drawings.*" (Record, p. 73, line 28.)

We are here directly referred to the drawings for further information concerning the manner in which the air and gas passages conduct the air and gas to the furnace.

Referring to the drawings as directed, we find that the air and gas reach the combustion chamber through conduits, marked by letters *e*, *e*, *f*, in such a manner that the air must necessarily pass over the gas. This, according to well-known physical laws, causes a perfect admixture of the air and gas in the combustion chamber. No such construction is described in English Patent, No. 167, and no such effect is produced.

This is admitted by the defendants' expert, Mr. Bergner:

"*X.* 35 *Question.* In your answer to cross-question 33 you say that the gas enters in an upward direction into the current of heated air passing over it. What would cause the current of heated air to pass over the gas in the United States Patent referred to?

"*Answer.* Because there is but one outlet for the two upward currents in a horizontal direction, and the upward current farthest removed from the outlet into the furnace *must pass over the vertical outlet from the inner or intervening regenerative chamber, and so cause a mingling of the two currents.*"

Mr. Park Benjamin describes and illustrates the advantages of the arrangement of the conduits as described in the Reissue, over the construction shown and described in the English Patent, No. 167 (*Answer* 11, Record, pages 38 to 43); and Mr. Waite says (*Answer* 13, Record, page 10):

"In the English Exhibit, No. 167, the gas and air are represented as entering the furnace side by side. In the United States Exhibit the air is represented as entering the furnace over the gas."

He also points out in this connection the advantages of placing the gas regenerative chamber between the air regenerative chambers, and of making the crown of the furnace over the entrance of the air flues at a higher level than the crown of the furnace over the gas flues. (Record, pages 14, 15, 25, and 26.)

The English Patent 167 contains no such claim as the Reissue, but had a claim, in substantially the same language been embodied in the English Patent, it would have covered a different invention from that claimed in the Reissue, because the words "constructed substantially as specified," and "in a manner so as to be operated as described," limit the claim to the construction and mode of operation shown in the drawings and described in the specification of the patent.

Different inventions cannot be made identical by using the same language in describing or claiming them; for instance, a churn and a pump might each be described and claimed in the same language, for each of these useful inventions may be said to have a traveling disk, to which is attached a rod which moves backward and forward through the head of the cylinder within which is located the reciprocating disk, and the same language might be applied to a steam engine and many other well-known but entirely dissimilar inventions.

An accurate regulation of the amount of air and gas admitted to the regenerators and combustion chamber, insuring a command of the quantity as well as quality of the heat.

The defendants' expert, Mr. Sellers, admits that it is essential in practice to "regulate the proportion of incoming gas and air." (Record, pages 100, 101, x-q. 41.)

The valves of the damper cases by which the flowage of air and gas into the furnace is regulated, are very clearly shown in the drawings of the Reissue, in Figures 1, 3, and 4, and are referred to in the specification in the following language :

"The valve Y will serve to arrest the flowage of air into the passage F, so with the passage X it will answer to close off the passage of gas into the damper case immediately underneath it." (Record, p. 74.)

As the necessity for valves of this kind for regulating the quantity of gas and air admitted to the furnace is acknowledged by all the experts who have testified in this cause, and as their utility is therefore admitted, it only remains to investigate the English Patent, No. 167, for the purpose of ascertaining whether such valves, or equivalents thereof, are shown and described in the specification of English Patent, No. 167.

A careful investigation of the drawings fails to disclose anything having the resemblance of a valve for regulating the amount of air admitted in the furnace. There is, however, a damper, marked *w* in Fig. 3, Sheet 1, of English Patent, No. 167, which is thus described in the specification : Valves *w* are provided in pipes T of each generator, so as to shut off communication with any one of them when not in use or under repair." Mr. Sellers, the defendants' expert, thinks that this valve might be used to regulate the flow of gas to the generator. (*Answer* 32, Record, page 97.)

This valve *w* in the pipe T is shown in Fig. 8 of the drawings of the Reissue, and is described in the specification as follows: "A valve *w* in the pipe T answers to close the latter as occasion may require." (Complainants' Record, page 74, line 23.)

It is to be noted, however, that in the Reissue, the inventors, although showing and describing "a valve *w* in the pipe T," which is identical with that shown in the English Patent, do not use it for the purpose of regulating the amount of gas admitted to the combustion chamber; on the contrary, they describe and claim the valve X, which is used in combination with the damper case, and say of it, "so with the valve X it will answer to close off the passage of gas into the damper case immediately underneath it."

Mr. Waite states positively that the valve marked *w* in the drawing of the English Patent, No. 167, and also in the Reissue, could not be used successfully to regulate the flow of gas to the regenerator. (Record, page 13, ques. 27.)

Figure 3 of the drawings of the Reissues indicate more clearly than any language in the specification could do, the facility with which the flowage of air and gas into the combustion chamber may be affected. By raising or lowering the valves there shown it is evident the gas and air currents may be relatively regulated and adjusted with the greatest nicety. The command of the temperature of the furnace and the quality of the flame is rendered complete, and the flame can be made at will, oxidizing, neutral, or reducing, without interfering with the temperature. No more gas need be admitted than can be properly burned; this is of importance, as any excess of gas or air only cools the furnace and does not add to its heat; if, however, a slightly smoky flame be required in a particular case, as for instance to prevent any oxidization of the charge,

such flame may be produced by the proper regulation of the valves relatively to each other.

The proper cooling of the bed of the furnaces and the arches of the regenerators.

This subject has already been considered partially under the head of "An adequate supply of air to the combustion chamber." In addition to what has been before stated, it may be here noted that the broad distinction between the cooling devices described in the English Patent, No. 167, and the chamber C, shown in all of the Figures of the United States Reissue, is that in the former patent for cold air, marked *e* in Fig. 3, Sheet 1, and *a* in Fig. 11, Sheet 2, are used to *perform the double function of cooling the bed of the furnace, and also supplying air to support combustion*, whereas in the latter Patent the inventors merely avail themselves of the law of nature, which causes air upon becoming heated to expand and rise. The cooling chamber is thus described in the Reissue: "Directly underneath the bed of the furnace A, and between it and the tops of two regenerators, B^2, B^3, there is an air chamber or space C, which communicates freely *at its opposite sides or ends with the atmosphere*, in order that a current of cool air may be caused to continually pass through it for the purpose of maintaining the bed of the furnace as well as the arches of the regenerators at a low temperature." (Record, page 73, line 29.)

The claim covering this important feature is as follows:

"We also claim the arrangement and combination of the air space or open chamber C with the furnace, and its system of regenerators arranged and applied together, substantially in the manner and so as to operate as described."

The open chamber mentioned in the claim is fully illustrated in the drawings. In the top view, Fig. 1,

we see the chimneys through which the hot air rises after it leaves the chamber C; no such chimney is shown in the English Patent, for the obvious reason that none is needed, as the cold air is drawn downward instead of being allowed to arise upon becoming heated.

In Fig. 2 the chamber is illustrated in vertical section, and in Fig. 3 in transverse section. In Fig. 4 the rear opening to the chamber is illustrated, and in Fig. 5 the front opening.

A comparison of the furnace thus illustrated and described with that illustrated and described in the English Patent shows, as is admitted by Mr. Sellers, the defendants' expert (Record, page 92, X 14 *Question*), that in the latter there is no cooling chamber beneath the bed of the furnace, all the parts of which communicate with each other in such a manner as to allow the air to pass freely about and around the underside of the furnace bed as in the United States Reissue. (Waite, ques. 21, Record, p. 12.)

A uniform distribution of the weight carried by the regenerator arches.

Stability of construction is, of course, a matter of great importance. (Waite, ques., 26.)

The defendants' experts admit that in the Reissue the partition walls between the air and gas regenerators extend vertically upward, and form the division walls between the air and gas flues. (Record, page 95.)

A person skilled in the art would not be able from the specification and drawing of the English Patent, No. 161, to make and use the alleged invention.

From what has been said it is evident that the invention patented by the complainants is not described or claimed in the English Letters Patent, No. 167, of 1861. We propose to go further, however, and establish the fact that a person skilled in the art of building furnaces

would not be able to construct from the specification and drawing of English Patent, No. 167, a furnace capable of actual use.

A United States Patent when produced is *prima-facie* evidence that in the specification there is contained a description in such full, clear, and exact terms as will enable any one skilled in the art to which it appertains to put it in practice (Poppenhusen *v.* N. Y. Gutta Percha Comb Co., 2 Fish., 62), because the law presumes that the Patent has been granted upon the proofs which the statute requires to be laid before the officers of the government, and that those proofs were satisfactory.

No such presumption, however, arises in regard to an English Patent, as patents are granted in England as a matter of course without any examination as to the novelty or utility of the invention, and without any inquiry as to whether the description in the specification "is in such full, clear, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most clearly connected, to make, construct, compound, and use the same." (Corning *v.* Burden, 15 How., 252.)

"*When a prior foreign patent is relied upon to defeat a patent*, the description and drawings therein must contain and exhibit a substantial representation of the patented improvement in such full, clear, and exact terms as to enable any person skilled in the art or science to which it appertains to make, construct, and practice the invention to the same practical extent as he would be able to do if the invention was derived from a prior patent in this country. Mere vague and general representations will not support such a defence, as the knowledge supposed to be derived from the publication must be sufficient to enable those skilled in the art or science to understand the nature and operation of the invention, *and carry it into practical use. It must be an account of a complete and operative invention capable of being put into practical operation.*"

This is the rule in this country and in England (Curtis on Patents, 4 Ed., sections 99, 368 *a*, 378 *b;* Seymour *v.* Osborne, 11 Wall., 516; Hill *v.* Evans, 6 Law Times N. S., 90; Betts *v.* Menzies, 4 Best & Smith, Q. B., 999; Cohn *v.* U. S. Corset Co., 93 U. S., 366; Cahill *v.* Brown, 15 Off. Gaz., 697; Hurwood *v.* Mill River Co., 3 Fish., 526.)

The defendant, upon whom rests the burden of proof, has introduced no testimony which establishes that the description and drawings of English Patent, No. 167, contain a substantial representation of the patented improvement in such full, clear, and exact terms as to enable any person skilled in the art or science to which it appertains to make, construct, and practice the invention. Nor has he placed any witness on the stand who is capable of giving such testimony. Neither Mr. Bergner nor Mr. Sellers have testified that they are acquainted with the art of building furnaces, and they are not therefore competent experts in that art.

Kilbourne *v.* Jenning, 38 Iowa, 533; Walker *v.* Fields, 28 Ga., 237; Pope *v.* Filley, 9 Fed. Rep., 65, 66; Dole *v.* Johnson, 50 N. H., 452, 455; Jones *v.* Tucker, 41 N. H., 546.

Novelty can only be negatived by proof which puts the fact beyond a reasonable doubt. (Coffin *v.* Ogden, 18 Wall., 120; Parham *v.* Machine Co., 4 Fish., 482; Sturly *v.* Sanderson, 8 Fed. Rep., 908; Green *v.* French, 11 Fed. Rep., 591; Wood *v.* Mill Co., 4 Fish., 560; Hawes *v.* Antisdel, 2 Ban. & Ard., 10; Begnell *v.* Harvey, 5 Ban. & Ard., 636.)

Mr. Waite, a mechanical engineer of twenty years' experience, who for the last fourteen years has made a specialty of the Siemens furnace, and has during that period been engaged in the designing, construction, and management of furnaces, and is familiar with the various processes to which they are applied, (Record, page 9,)

swears that a person skilled in the art of building furnaces would not be able to construct from the specification and drawing of English Patent, 167, a furnace capable of actual use for the purpose of manufacturing iron and steel or for any purpose whatever. (Record, page 10, qq. 9–12.)

Presumption arising from the action of the Commissioner of Patents.

It has frequently been held, when an extended term is granted in *apparent conformity to the Act of Congress*, that the decision of the officer granting the extension has the attribute of a final judgment. It is not subject to appeal or revision, and it cannot be shown that the Commissioner exceeded or irregularly exercised his authority, *except by matter apparent on the face of the patent.*

Clum *v.* Brewer, 2 Curt., 506; Brooks *v.* Bicknell, 3 McDean, 250; Colt *v.* Young, 2 Blatch., 471; Goodyear *v.* Providence Rubber Co., 2 Fish., 499; and on appeal, 9 Wall., 788; Jordan *v.* Dodson, 4 Fish., 232; Gear *v.* Grosvenor, 6 Fish., 314; Rubber Co. *v.* Goodyear, 2 Fish , 499; and on appeal, 9 Wall., 488; Cromton *v.* Belknap Mills, 3 Fish., 536; Eureka Co. *v.* Bailey Co., 11 Wall., 488; Mowry *v.* Whitney, 5 Fish., 496; and on appeal, 14 Wall., 620; Tilghman *v.* Mitchell, 4 Fish., 615.

In the present case the term was granted in apparant conformity to the Act of Congress, and there is nothing on the face of the patent to indicate that the Commissioner exceeded or irregularly executed his authority in granting the patent for seventeen years from its date of issue.

Corning *v.* Burden, 15 How., 271; Wilder *v.* McCormick, 2 Blatch., 34; Alden *v.* Dewey, 1 Story, 341; Hotchkis *v.* Greenwood, 4 McLean, 456; same case on appeal, 11 How., 248.

It is a presumption of law that all public officers perform their proper official duties until the contrary is proved. Under the Act of 1836 and 1839 it was the duty of the Commissioner of Patents to thoroughly examine all applications for Letters Patent, and if it was found that the invention claimed therein had been "patented in a foreign country more than six months prior" to the application, he was required to limit the patent "to the term of fourteen years from the date or publication of such foreign patent."

If, then, it was the duty of the Commissioner to limit the term of the patent, the fact that he has not done this is evidence that the invention claimed was not described or shown in English Patent, No. 167. (Phila. & Trenton R. R. *v.* Stimpson, 14 Peters, 458.) The burden of proof is upon a party who claims that the patent should be limited in duration to show the facts which limit it. (American Diamond Rock Boring Co. *v.* Silden, 17 Blatch., 303.)

Construction of the Claims.

1. The Act of 1837, which was in force when the patent was granted, provided that "the applicant for a patent shall be held to furnish duplicate drawings, whenever the case admits of drawings, one of which is to be deposited in the office, and the other to be annexed to the patent and *considered a part of the specification.*"

When it becomes necessary to construe a claim narrowly, in order that its novelty may not be negatived by the prior art, courts will give such a narrow construction, and "should proceed in a liberal spirit, so as to sustain the patent, *and construction* claimed by the patentee himself, if this can be done consistently with the language which he has employed. (Klein *v.* Russell, 19 Wall., 433; Walker on Patents, 132.)

In the case referred to the court applied the rule in

construing a claim for "the employment of *fat liquor* in the treatment of leather," and said: "We think the better opinion is that the first claim was intended to cover, and does cover, only the use of *heated* liquor." *Fat* liquor had been used before.

Mr. Curtis says (Curtis on Patents, 4th ed., section 262): "In the case of machinery the statute directs the patentee to accompany his specification with a drawing or drawings and written references, when the nature of the case admits of drawings." The object of annexing the drawings is to distinguish the thing patented from other things known before, and to explain the mode of constructing the subject of the patent. It has been settled that the drawings constitute a part of the specification when annexed thereto, and may be used to explain or help out the otherwise imperfect description in the specification, so that it is not *necessary that the description should be wholly in writing, but it may be partly in writing and partly in drawing; and if, by a comparison of the words and the drawings, the one will explain the other sufficiently to enable a skillful mechanic to perform the work and to show what is the invention claimed*, the specification will be sufficient. And it has been held that, in order to make a drawing, when annexed to and accompanying a specification, part of the specification, so that the written description may be read by it, it is not necessary that the written description should contain references to the drawing; that the direction in the statute to annex drawings and written references "means *that when references from the writing to the drawings are necessary to understand the machine or improvement, they are to be made; but that the description of many machines or improvements, when accompanied by a drawing, may be perfectly understood without references to the description itself.*" This concise statement of the law is fully borne out by the authorities. (Earle

v. Sawyer, 4 Mass., 1; Swift *v.* Whissen, 3 Fish., 343; Brooks *v.* Bicknell, 3 McLean, 250, 261; Washburn *v.* Gould, 3 Story, 122, 133; Hogg *v.* Emerson, 11 How., 587, and 6 How., 437; Kittle *v.* Merriam, 2 Curtis, 475; Emerson *v.* Hogg, 2 Blatch., 1; Hienrich *v.* Luther, 6 McLean, 348.)

In construing the claims, therefore, it is immaterial whether we refer to the part of the specification which is in writing or the part which is in drawing. (Webster Loom Co. *v.* Higgins, 105 U. S., 580.) In Brunton *v.* Hawkes, (1 Carp., P. C., 410,) Abbott, C. J., said: "If a drawing, or figure, enables workmen of ordinary skill to construct the improvement, it is as good as any written description." Said Lord Westbury (10 L. T. Rep., N. S., 146): "It was concluded by the plaintiff's counsel, and perhaps justly, that a patent for a new machine would be good if the specification contained nothing but clear drawings of the machine and a description of them." (Foxwell *v.* Bostock, 10 L. T. Rep., N. S., 146.) Said Malins, V. C.: "A specification may consist of a drawing alone." (Ponpord *v.* Fardell, 18 W. R., 129.)

2. There are two sources to which we are entitled to resort in construing the claims: First, the state of the art to which the invention relates prior to the invention of the patentees. (Blaisdel *v.* Tufts, 15 Off. Gaz., 881; Pitts *v.* Wemple, 2 Fish., 10; Burden *v.* Corning, 2 Fish., 477; Rubber Co. *v.* Willing, 97 U. S., 7; Carleton *v.* Bokee, 17 Wall., 463; Washing Machine Co. *v.* Tool Co., 20 Wall., 342; Duff *v.* Sterling Pump Co., 107 U. S., 636). Second, the description in writing and in drawing contained in the specification.

The state of the art as it existed prior to the joint invention of C. W. and F. Siemens is illustrated by the English Patent, No. 2861, which was granted to Frederick Siemens, December 2d, 1856, which has been

introduced in evidence by the complainants. (Record, p. 75.)

The scope of a joint invention and the claims of a Patent founded thereon will be ascertained and limited in view of pre-existing devices, which were the sole invention of one of the joint patentees. (Hopkins & Dickenson Manufacturing Co. *v.* Corbin *et al.*, 14 Blatch., 396.)

It is not, of course, contended that the English Patent of Frederick Siemens, above referred to, describes or shows an invention which may be reduced to practice, but it is submitted that it should be considered in construing the claims of the Reissue, as "it is impossible that one person can be at the same time the joint and sole inventor of the same invention." (Barrett *v.* Hall, 1 Mass., 447). Letters Patent may be construed in the light of the cotemporaneous construction of the inventor. (Trader *v.* Mussmore, 1 Ban. & Ard., 639.)

The application of this rule will establish that the theories of the defendants' experts regarding the scope of English Patent 167, and also of the Reissue, are erroneous, and that they have entirely misunderstood the invention disclosed by these Patents.

It will be obvious, from a perusal of their testimony, that what they consider the primary and essential features of the Messrs. Siemens' joint invention is the sole invention of Mr. Frederick Siemens, and is claimed by him as such in his English Patent of 1856.

C. W. and F. Siemens' Patent of 1861.

The claim of this Patent is as follows:

"Having now described the nature of our invention, and the best modes we are acquainted with for performing the same, we wish it to be understood that we do not confine ourselves to the precise details shown on the accompanying drawings, but we *claim as our invention the various arrangements of regenerative furnaces*

worked by gases resulting from an imperfect combustion of solid fuel in separate places, as hereinbefore set forth."

In setting forth the nature of their invention in the specification the inventors say:

"These improvements relate to that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion, and communicate the same subsequently to the supporting of combustion. *It is an essential part of our invention that the solid fuel used, such as coal, lignite, peat, etc., should be decomposed in a separate apparatus*, so that the introduction of the solid fuel into the furnace may be altogether avoided, and the gaseous fuel may be heated to a high degree prior to entering into combustion with atmospheric air, also heated to a high degree, thus causing a great economy of fuel."

No such language is found in the Reissue.

This language and the rest of the specification, taken in connection with the state of the art, as disclosed in the prior patent of Mr. Frederick Siemens, shows clearly that the inventors considered their joint invention to consist in a regenerative furnace or furnaces, such as described in the prior patent, "worked by the gases resulting from the imperfect combustion of solid fuel." (Record, page 163, lines 25 to 36.)

The Court below seems to have been greatly misled and deceived by the similarity of the language in United States and English specifications, but where the language of description is the same in the two Patents it will be found to refer to matter which is not claimed in the first three claims of the United States Patent. For instance, the features described in the Reissue specification, from line 22, page 71, of the Record to line 16, page 63 thereof, is not claimed or even hinted at in the claims.

The gas generator and its combination with the furnace is fully described in the Reissue, but no allusion

whatever is made to it in the claims, and there is no reason to suppose that it is any part of the invention patented. In fact, the expert of the defendant, Mr. Bergner, testifies that he is aware that a gas producer of this construction is shown in another patent of the complainant not involved in this suit.

An Invention which is not Claimed is not Patented.

It is very clear that the invention claimed in the Reissue is not claimed in the English Patent, and it has been held since the appeal in this case was taken that the mere description of an invention in a foreign Patent does not operate, under Section 4887 of the Revised Statutes, to limit a domestic Patent for the same invention. Holmes Electric Protective Company *v.* Metropolitan Burglar Alarm Company, 32 Off. Gaz., 384, was a suit brought for an infringement of Letters Patent No. 120,874, granted November 4, 1871. An injunction was granted, after argument, September 2, 1884. On November 22 defendant moved to vacate the injunction. The ground of this motion was that the invention had been previously patented by the inventor in an English Patent, November 1, 1870, the term of which expired November 1, 1884, and that by consequence the patent in suit expired at the same time. Complainants opposed the motion on the ground that while the invention was *described* in the specification of the English Patent, it was not "patented" therein within the meaning of the statute, the *claims* of the English patent not being for the invention set forth in the claims of the patent in suit. Mr. Justice Wheeler said:

"The invention patented in the patent in suit, as the same was construed in granting the injunction now sought to be dissolved, was not patented in the English Patent which has expired, the expiration of which is relied upon to terminate this patent, and is the ground of this motion.

"It is only a patent for an invention that has been previously actually patented in a foreign country that is limited by the foreign patent. The description of the invention in the foreign patent might affect the validity of the domestic one, and might not, but would not, limit it." (Rev. Stat., 4887.)

The First Claim of the Reissue.

The first claim is as follows:

"We claim, in *combination* with the furnace A and its chimney or smoke-discharge flue P, a system or series of air and gas regenerators, B^1, B^2, B^3, B^4, *constructed substantially as specified*, and having *conduits* and *dampers* arranged so that air and gas may be led into and through such regenerators and furnace and out of the chimney *in manner and so as to be operated as and for the purpose or purposes hereinbefore described.*"

This is evidently a claim for a combination, and as it contains the qualifying words, "substantially as specified," and "in the manner and so as to be operated as and for the purpose or purposes hereinbefore described," the claim must be limited by the history of the art (Carlton *v.* Bokee, 17 Wall., 463) and by the specification. (Seymour *v.* Osborne, 11 Wall., 516.)

Having reference to the specification in writing and in drawing, the essential parts of the combination may be defined and enumerated as follows:

1. The furnace A, the crown of which over the air conduit is so arranged that the air rises to a higher level than the gas, and must necessarily be projected in the furnace above the gas.

2. The *regenerators* arranged in such a relation to each other and to the air and gas conduits that the air and gas pass upward in parallel streams.

3. The *conduits* for air and gas leading from the regenerators to the furnace, whereby the air is delivered into the furnace above the gas, and one of the objects

of the invention is effected, *i. e.*, "to produce heat by the combustion of gases and atmospheric air *in mixture.*"

4. The conduits "arranged so that the air and gas may be led into and through such regenerators and furnace and out of the chimney *in manner and so as to be operated as and for the purposes described.*" Having reference to the specification to ascertain how these conduits are operated and for what purpose, we find that they are provided with valves, X and Y, which accurately regulate the amount of gas and air led through them.

5. Dampers of oval form arranged within a circular damper case and placed near the valves X and Y.

The defendants have seen fit to cross-examine the complainants' witnesses to a considerable extent concerning a reissue patent obtained by C. W. Siemens, in 1877, thirteen years after the original of Reissue No. 3265 was granted, although no mention of such patent was made on the direct examination, and have filed the Reissue as a supplemental record, although it was not referred to in the answer, and complainants' counsel had no notice of it. The only comment which Mr. Justice Butler has to make upon this procedure will be found in his opinion (Record, page 194). He says: "At a later date C. W. Siemens, one of the complainants, discovered that the method of introducing air and gas might be improved, and in 1877 obtained a patent in this country for his improvement. *Still, however, no suggestion is made respecting the importance of introducing the air above the gas.*" Comment upon this statement of the learned judge is unnecessary. It is only requisite to refer to the specification of the patent to which he refers (Record, page 187, line 23): "I prefer to cause the air to enter the heating chamber above the gas, as by its superior specific gravity at equal temperatures it tends to sink

through the gas, and thus an intimate mixture and more perfect combustion is obtained," and to its 2d claim which is as follows: "A regenerative gas furnace in which the air is introduced at a level superior to the gas, *as and for the purpose described.*" If we may be allowed to make a reference to the state of the art before the date of the patent, which was not made in the Court below (Brown *v.* Piper, 91 U. S., 37), attention is respectfully directed to the following passage in Percy's Metallurgy of Iron, describing a Siemens furnace: "The air required for the combustion is directed by the air-valve d (Fig. 169, 173) into the left-hand air regenerator, and rising through it enters the mixing chamber *behind* the gas, and therefore when the air and gas pass forward together into the puddling chamber *the air is above the gas*, and tending from *its greater specific gravity to sink through it produces a perfect mixture.*" (Percy's Metallurgy of Iron, p. 684; published in London, 1864.)

It may be here remarked that the fact that air by its superior specific gravity at equal temperatures will sink through gas is a law of nature which cannot be claimed or patented, but devices for harnessing this law of nature may be patented. It is a function or result of the combination claimed in the Reissue No. 3265 and also of combinations claimed in the patent of C. W. Siemens, No. 7863, and each of these patents cover only the particular devices by which the result is effected.

The Second Claim.

The second claim is as follows:

"We also claim the arrangement and combination of the air space or open chamber C with the furnace and its system of regenerators, arranged and applied together substantially in manner and so as to operate as described."

This is a combination of the following elements:

1. The *open* chamber C, which "*communicates freely at its opposite sides or ends with the atmosphere.*"

2. The furnace.

3. The regenerators.

The function of this combination is the cooling of the furnace and also the regenerators by a current of air, *which is caused to circulate by the heat imparted by the furnace.*

Third Claim.

The third claim is as follows:

"We also claim the arrangement and combination of the air chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper chests applied thereto, the whole being substantially as specified."

This is a combination of the following elements:

1. The air chamber or space D (provided or not as may be preferred with the space E) for holding the damper case and supplying it directly with air.

2. The furnace.

3. The regenerators.

4. The conduits for air and gas between the regenerators and the furnace.

5. The conduits by which air and gas are led to the regenerators.

6. The damper chests, provided with dampers and air-regulating valves, and applied to the space D.

The object of the combination is to supply the damper case directly with air, or, in other words, to put it in direct communication with the outer atmosphere, and at the same time place it in a position where its damper and air-regulating valve may be conveniently worked by the operator, who, in regulating the furnace, should be able to see immediately the effects of any alteration in the dampers or valves.

The features claimed in the first three claims above quoted will be found described in the specification, as printed, from line 1 to line 16, page 70 of the record, and from line 17, page 73, to line 43, page 74; and although attempts have been made to sophisticate the issue, by comparing mere surplusage and unclaimed matter in the Reissue, which forms the subject-matter of another U. S. patent, with the language of the English specification, it has been found impossible to find any language in the English patent similar to this description of the features claimed.

Fourth Claim.

The fourth claim is as follows:

"We also claim the combination of a furnace with *one or more* regenerators or means of receiving waste, smoke, and gaseous products, and intercepting or receiving heat therefrom, and also with means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas during its passage into such furnace."

This claim does not contain any words referring back to the descriptive parts of the specification, but where the words "as described," or "substantially as described," are not used in the claim they will be implied (Mitchel *v.* Tilghman, 19 Wall., 287); and the claim will be limited by the history of the art. (Seymour *v.* Osborne, 11 Wall., 547; Carlton *v.* Bokee, 17 Wall., 456.)

Keeping in view the patent of Mr. Frederick Siemens, above referred to, which shows and describes "a furnace with one or more regenerators or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom," it is evident that this claim, in the light of the history of the art, must be interpreted to be for a combination of the following element:

1. *One or more* regenerators substantially as described in writing, and in drawing the specification.

2. The furnace.

The novel results of this combination are that the air and gas currents are delivered upward in parallel columns into the conduits leading into the furnace. The passages H, I, K, L, arranged underneath the regenerators, are arched by fire-brick arches. A uniform distribution of the weight carried by the regenerator arches is effected. The passages connecting the damper cases and regenerator chambers are more nearly of an equal length than in the construction shown in the prior patents, and the distance traveled by the air and gas from the regenerators to the furnace is equalized.

But if it be admitted that this claim is anticipated by the English patent of 1861, this would not invalidate the first three claims of the patent.

SECOND.

We maintain that a patent granted in this country, subsequent to the Act of 1861, and prior to the Act of 1870, for a term of seventeen years from the date of issue for an invention which was also patented in a foreign country by the same person, "more than six months prior to his application," under the Act of 1861, "remains in force for the term of seventeen years from the date of issue."

Under the Act of 1861, the patent upon which this suit is brought, runs, according to its tenor, and "remains in force, for the term of seventeen years from March 1, 1864," even if it is proved that the whole or any part of the invention claimed in said patent was patented in England "more than six months prior" to the application in this country; because the proviso of the Act of 1839, "that in all such cases every such patent shall be limited to the term of fourteen years

from the date of publication of such foreign patent," was repealed by the Act of 1861, which provides that "*all* patents hereafter granted shall remain in force for the term of seventeen years from the date of issue," and repeals "All Acts or parts of Acts heretofore passed which are inconsistent with the provisions of this Act."

If violence is to be done to the usage of the English language in giving words a meaning which they never were supposed to have before, and construing the 16th section of the Act of 1861 to say one thing and mean another, such a departure from the literal meaning of the words used in the statute can only be excused on the ground that it is permissible to ascertain the source of the intention of the legislature by a consideration of other Acts in *pari materia*, the mischiefs of which were the cause of the passage of the act of 1861. Let us first consider the acts in *pari materia*, which were not in force at the date of the patent.

Act of 1790, article 1, section 8, of the Constitution authorizes Congress "To promote the progress of science and the useful arts by securing for *limited times* to authors and inventors the exclusive right of their respective writings and discoveries. "These limited times" have been secured by the following legislation:

The act of 1790 provides, "That upon the petition of any person or persons to the Secretary of State, the Secretary for the Department of War, and the Attorney General," * * * "Letters-Patent may be granted to the petitioner for any term not exceeding fourteen years," etc.

This Act, like the English and French laws, made no distinction between citizens and foreigners (Phillips on Patents, page 69); that is to say, a citizen of Great Britain or any foreign country could take out a Patent for the same term as a citizen of the United States. It is also to be observed that this Act did not fix the term

of the Patent. The clause "not exceeding fourteen years," is the same as that used in the English Statute, which had been construed to leave it optional with the King when he sees occasion to grant a patent for less than fourteen years. Under this Act the fact that the invention had been patented in a foreign country had no effect upon the term of the grant here.

Act of 1793. The Act of April 10, 1790, above cited, was repealed by the Act of 1793. The latter Act used substantially the same language in regard to the term for which the patent was to be granted as the former, *i. e.*, "for a term not exceeding fourteen years," and under it, as in the Act of 1790, the fact that the invention had been patented abroad had no effect upon the term of the grant here; but a new policy was introduced, in that the party applying for a patent, in order to be entitled to the grant, must not only have been the original and sole inventor, but must also have been a citizen of the United States. This was a departure not only from our own, but from the practice under both the English and French laws on the same subject, by both of which patents are granted to foreigners as well as English and French subjects. (Phillips on Patents, page 69.)

Act of 1800. After the right of taking out a patent had been for seven years confined exclusively to citizens under the law of 1793, the Act of April 17, 1800 (2 Stats. at Large, 37) was passed, by which the privilege was extended to resident aliens; but the act is silent upon the subject of foreign patents and their effect upon patents subsequently obtained in the United States.

Act of 1832. This Act was passed to extend the privilege of obtaining patents to aliens who had declared their intention of becoming citizens; the act is silent, however, upon the subject of inventions patented abroad.

Act of 1836. The Acts of 1793, 1800, and 1832 were

all repealed by the Act of 1836, (5 Stats. at Large, 117,) which reinstated the policy of the original Patent Act of 1790, and allowed aliens to take out patents for the same term as citizens; and this has ever since been the policy of the law.

The term of the patent under the Act of 1836 remained unchanged, and the same language was used in defining it as in the statutes repealed, *i. e.*, "for a term not exceeding fourteen years." This language has been frequently explained and construed.

Thus Mr. Justice Dunlop uses the following language: "A patentee under this section need not claim the whole fourteen years. He may waive his claim to a part of the term in favor of the public." (*Ex-parte* Cushman, Laws' Digest, p. 506.) And in Sulivan's case, Wirt, Attorney-General, says: "A patent may issue for a less term. The restriction is upon the maximum only, not upon the minimum." (Opin. Att'ys-Gen., 168, Gilpin's Ed.)

The only provisions of the Act of 1836 which it is necessary to consider, are to be found in sections 5, 6, 7, and 8. Section 5 provides that "all patents *issued* from said office shall be *issued* in the name of the United States, and under the seal of said office," etc., and "every such patent shall * * * in its terms grant to the applicant or applicants, his or their heirs, administrators, executors, or assigns, for a term *not exceeding fourteen years*, the full and exclusive right and liberty of making, using, and vending to others to be used, the said invention or discovery," etc. Section 7 provides, among other things, that if it shall not appear to the Commissioner "that the alleged new invention or discovery had *been patented* or described in any printed publication in this or any foreign country," * * * "it shall be his duty to *issue* a patent therefor."

Section 8 is as follows:

"But nothing in this Act contained shall be construed to deprive an original and true inventor of the right to

a patent for his invention by reason of his having previously taken out Letters Patent therefor in a foreign country; and the same having been published at any time within six months next preceding the filing of his specifications and drawings, and whenever the applicant shall request it, the patent shall take date from the time of the filing of the specifications and drawings, not, however, exceeding six months prior to the actual issuing of the patent."

It is obvious that there was nothing in these sections of the Act of 1836 which limited the term of a United States patent on account of a prior patent taken out in a foreign country. Section 7 of the Act uses the words, "had been patented or described in any printed publication," evidently treating a foreign patent as a publication in this country; and if an applicant complied with the requirements of section 8, and applied for a patent in this country within six months after the publication of a foreign patent, he obtained a patent for the same term as if no foreign patent had been granted. His patent bore the date of issue, and was in force "for a term not exceeding fourteen years," like any other patent. It is true that, by the eighth section of the Act of 1836, the policy of refusing a patent on the ground that the invention had been previously patented abroad seems to have been first introduced, but this was evidently on account of the analogy between a patent and a printed publication.

Act of 1839. The 6th section of this Act provided, "that no person shall be debarred from receiving a patent for any invention or discovery, as provided in the Act approved on the 4th day of July, 1836, to which this is additional, by reason of the same having been patented in a foreign country more than six months prior to his application: *Provided*, That the same shall not have been introduced into public and common use in the United States prior to the application for such

patent. *And provided, also,* That in all cases every such patent shall be limited to the term of fourteen years from the *date or publication* of such foreign patent.

It is to be observed in regard to this statute:

First. That the six months' limitation of the Act of 1836 remained unaffected.

Second. That a new policy was introduced in granting to a certain class of patentees an absolute term of fourteen years, instead of the "term not exceeding fourteen years," mentioned in the Act of 1836 and all statutes prior thereto.

Third. The statute was granted for the relief of inventors whose foreign patents were dated *more* than six months prior to the application in this country. It had, of course, no reference to those whose patents were dated less than six months before such application, for the very plain reason that they needed no relief, as they stood upon the footing of ordinary applicants. It was confined expressly to inventions for which Letters Patent were taken out in a foreign country more than six months prior to the filing of the application here, and declares such inventions patentable under certain limitations. The Act of 1836 referred to this class of cases, and in effect treated them as unpatentable. To the extent, therefore, of treating this class of cases as unpatentable, it was repealed by the Act of 1839; in other respects the Act of 1839 is not inconsistent with the Act of 1836, but is, as it professes to be, additional to it.

Act of 1861. The language of the 16th section of the Act of 1861 is as follows:

"All patents hereafter granted shall remain in force *for the term of seventeen years from the date of issue*, and all extensions of such patents are hereby prohibited;" and the repealing clause of the Act is, "that all Acts and parts of Acts heretofore passed, which are inconsistent with the provisions of this Act, be, and the same are, repealed."

The Act of 1870 was a general Act to revise, consolidate and amend the statutes relating to patents, and section 25 thereof provides: "That no person shall be debarred from receiving a patent for his invention or discovery; nor shall any patent be declared invalid, by reason of its having been first patented or caused to be patented in foreign country: *Provided*, The same shall not have been introduced into public use in the United States for more than two years prior to the application, and *that the patent shall expire at the same time with the foreign patent*, or if there be more than one, at the same time with the one having the shortest term."

The Act of 1839 was the first Act which establishes a fixed, certain and definite term; the Act of 1870, on the other hand, makes the term uncertain and indefinite.

Under the Act of 1839 the face of the patent showed the term for which it had been granted. Under the Act of 1870 the face of the patent cannot indicate its term, for although granted for a fixed and definite number of years it "will expire at the same time with the foreign patent."

POLICY INDICATED BY THE FOREGOING ACTS.

1. Since the passage of the law of 1836 it has always been the policy of the law to allow aliens to take out a patent for the same term as citizens of the United States.

2. Although it may have been the policy of the legislation prior to the Act of 1861 and under the Act of 1870 to make an invention free in this country because the patent has expired abroad, such a policy would logically lead to absurd results and would debar an inventor from taking out a patent in this country, unless he also patented the invention in other countries, for it certainly follows from the premises, "an invention should be free in this country as soon as it is free abroad," that if no patent is taken out abroad, and the

invention is free in foreign countries, the invention should always remain free here, and would consequently be unpatentable. The policy of limiting an American Patent on account of the term of a foreign patent, and granting a patent for a full term in case no patent is taken out abroad, would lead to the following result if subjected to a logical test:

If the term of the foreign patent is lessened, the term of the United States Patent must also be lessened. If the term of the foreign patent is reduced to one year, the term of the United States Patent is reduced to one year. If, however, the term of the foreign patent is reduced to 0, the term of the United States Patent expands to seventeen years.

3. The law regards a patent as being a contract between the inventor and the public, in which the privilege conferred on the inventor is the consideration received by him for making the invention public, so that all may use it after the expiration of the patent term. If the reward of the inventor is to be commensurate with the benefit conferred on the public, it would certainly be just and equitable that the inventor who patents his invention abroad should receive a longer term than the inventor who does not, for in the former case the value of the invention in this country is enhanced by preventing foreign competition.

4. It is a matter of common notoriety that the provision of the Act of 1870, limiting the term of a United States patent to the term of a patent taken out abroad, is condemned, except by a small class of persons who profit by infringing patents, and it is a matter of wonder that it still remains upon the statute book. The Committees of Congress, after a thorough investigation, have advised its repeal. In the recent elaborate discussions before the Committees on Patents of the Senate and House of Representatives on the amendment of the

statutes in relation to patents, all the interests represented concurred in urging its repeal. (45th Congress, 2d Session, Mis. Doc. No. 50.)

The Commissioner of Patents, in a message to Congress, uses the following language in recommending the repeal of this obnoxious law:

"Section 19 is intended to remove the restriction placed upon patents in this country by reason of the prior issue of foreign patents for the same invention in foreign countries. Under the existing law, the lifetime of an American Patent is abridged if the inventor has taken out a foreign patent prior to the issue of the American patent, when the foreign patent expires before the termination of the seventeen years, which otherwise the American patent would run. The simple effect of the present law is to tend to discourage American inventors from taking out foreign patents. I know of no advantage whatever arising from this provision of the law." (45th Congress, 2d Session, Mis. Doc. No. 50, page 218.)

As, therefore, section 25 of the Act of 1870, retained in the Revised Statutes as section 4847, introduced a scheme into the law which is universally admitted to be against public policy, it cannot be cited to affect in any way the construction to be placed upon the Act of 1861.

Construction of the Act of 1861.

It is obvious that the Act of 1861 introduced two new features:

First. It abolished extensions, except by special Act of Congress.

Second. It established a fixed and certain term of seventeen years for all patents in lieu of a term depending upon the discretion of the Commissioner of Patents.

That the object of the law was to abolish extensions appears upon its face, and also from the action of Congress. (Cong. Globe, Part 2, 1860–61, 1248, 1431.)

In exchange for the right of applying for a seven-years' extension it gave to the inventor an absolute and certain term of seventeen years, and as aliens and persons who had patented their inventions abroad more than six months prior to taking out a patent in this country, possessed the right of applying for a seven-years' extension, and as extensions were frequently granted to such persons, it is obvious that they were also entitled to this absolute term of seventeen years. The statute abolished the power of the Commissioner to limit the term of the patent, which, as we have seen, he possessed under the Act of 1836, in order to render it certain that in all cases the patentee should enjoy the full term of seventeen years given in lieu of the privilege of obtaining an extension.

The section under consideration provides that "all patents hereafter granted shall remain in force for the term of seventeen years *from the date of issue.*"

What is the date of issue?

The ordinary signification of the word "*issue*," as commonly used, is well known, and need not be discussed.

It is frequently used in the statutes relating to patents, in the rules of the Patent Office, and in decisions of the courts relating to patents, and always in its ordinary and well-known sense. Thus in the Acts relating to patents, we have the following language: "All Patents *issued* from said Office shall be *issued* in the name of the United States." "It shall be his duty to *issue* a patent therefor." "With which letters patent and papers *issued* from the Office shall be authenticated." "All duties respecting the granting and *issuing* of patents directed by law." "Patents may be granted and *issued* or reissued to the assignee," "for which a patent was *ordered to issue* upon payment of the final fee," "for which a patent was ordered to *issue* under such renewed

application prior to the *issue* of the patent." "On the *issuing* of each original patent."

In another section of the Act of 1861 than that under consideration (Section 10), it is provided that a fee of twenty dollars shall be paid "on the issuing of each original patent." Construing section 16 with this section, it would seem that the "date of issue must be some date on or after the payment of the fee of twenty dollars, as this payment is made a condition precedent "to the issuing of each original patent." We may therefore conclude the "seventeen years from the date of issue" must be seventeen years from some period on or after the payment of twenty dollars fee.

Webster defines issue, "The act of sending out or causing to go forth; delivery; as the issue of an order from a commanding officer or from a court; the issue of money from the treasury;" and it is obviously in this sense that the word is used in the patent laws.

In reading the section of the Act of 1861, under consideration, it strikes one forcibly that there is really nothing to construe. The object of the law was to abolish extensions, which, owing to the bad methods at the Patent Office, had become unpopular, and to grant in lieu thereof a longer term to persons who, under the former legislation, would have been entitled to apply for an extension, including, of course, inventors who had first patented their inventions abroad. This is universally admitted.

The object and policy of the law being known, and its language perfectly plain and unambiguous, it would seem that there can be no construction where there is nothing to construe.

In cases of this character the courts follow the letter of the law and leave the responsibility of its policy to the legislature. A great number of cases might be cited to sustain this proposition which are familiar to the court.

Vattel states the rule as follows:

"The first general maxim of interpretation is that it is not permitted to interpret what has no need of interpretation. When an act is in clear and precise terms, when the sense is manifest, and leads to nothing absurd, there can be no reason to refuse the sense which the words naturally present."

The construction laid down in DeFlorez *v.* Reynolds demands that the word "fourteen," in the Act of 1839, shall be stricken out, and the word "seventeen" be substituted therefor, and that the policy first introduced by the Act of 1839 shall apply to Patents granted after the passage of the Act of 1861, notwithstanding the language of the latter act directly to the contrary.

If Congress intended that all Patents issued after the passage of the Act of 1861 should run for seventeen years, it could not have used plainer and more certain language in signifying its intention, and there is not a particle of evidence showing any other intent.

The Act of 1861 repealed all Acts, or parts of Acts, inconsistent therewith. The proviso of the Act of 1839, sec. 6, that the patent "shall be limited to the term of fourteen years from the date of publication" of a prior patent, is undoubtedly inconsistent with the Act of 1861, and was therefore repealed.

It is impossible to reconcile the Act of 1861 with the Act of 1839 without at least two important changes, for neither of which is there any authority. "All patents," in the former Act, must be construed to mean less than all, and the patent must run, not from the "date of issue," but "from the date of the foreign patent."

The construction laid down in DeFlorez *v.* Reynolds makes a still further change in making the term run for seventeen years from the date of publication of the foreign patent, instead of fourteen; it also requires that the

Act of 1839 shall be amended to make it consistent with the Act of 1861, although repealed by the latter Act.

It is to be observed that the provision of the Act of 1861 is general, and applies to and covers all Patents which may be thereafter granted, and that no express or implied exception is made as to any particular class of Patents. The section of the same Act as to Patents for designs is a specific enactment for a particular class of Patents, and does not, of course, qualify the general provisions of the Act.

For the court to say that section 16 of the Act of 1861 applies only to a particular class of Patents, would be the exercise of legislative power which the court does not possess; it would change the terms and language of the section, and would, in fact, make it another enactment.

The three reported cases bearing upon the question are: Weston *v.* White, 13 Blatch., 364; Goff *v.* Stafford, 14 Off. Gaz., 748; and DeFlorez *v.* Reynolds, 17 Off. Gaz., 503.

In Weston *v.* White, the Patent in suit bore date August 6th, 1867, and the English Patent was published October 22d, 1859, and it was held that the United States Patent would expire October 22d, 1876, seventeen years from the date of the English Patent. The question arose on motion for preliminary injunction, and Judge Shipman, who decided the case, cites no authorities in support of his position.

Mr. Justice Blatchford, in deciding the case of DeFlorez *v.* Reynolds (17 Off. Gaz., 503), uses the following language in reviewing this decision:

"In Weston *v.* White (13 Blatch., C. C. R., 364), the United States Patent was granted August 6, 1867. A prior English Patent for the same invention had been granted to the patentee, and had been published October 22d, 1859. The question arose in May, 1876, whether the United States Patent had expired October 22d, 1873,

at the expiration of fourteen years from October 22d, 1859, or whether, under section 16 of the Act of 1861, it remained in force in May, 1876. If it should expire October 22d, 1876, (being seventeen years from October 22d, 1859), or if it should remain in force till August 6, 1884, (being seventeen years from August 6, 1867), it remained equally in force, in either case, in May, 1876. It was necessary, in May, 1876, only for the court to decide that the Patent had not, under section 6 of the Act of 1839, run out in fourteen years from October 22d, 1859, *and the question whether it would run out October 22d, 1876, or not till August 6, 1884, was not directly involved, nor does it seem to have been argued or considered, except as may be inferred from* the fact that the court says that the Patent would not expire until October 22d, 1876, and further says that the effect of the sixteenth and seventeenth sections of the Act of 1861, was that Patents issued after the passage of the Act of 1861, and falling within the proviso of section 6 of the Act of 1839, would run for seventeen years from the date of publication of the foreign Patent. The case was one in the Circuit Court of the United States for the District of Connecticut, before Judge Shipman."

The case of Goff *v.* Stafford was decided by Mr. Justice Clifford, October 9, 1878.

English Letters Patent, No. 1,486, dated June 13, 1863, were sealed, and the complete specification filed, in December, 1863. Domestic Letters Patent for the same invention were granted the foreign patentee October 3, 1865, which he on the 25th of June, 1877, assigned to one of the complainants.

One of the defences set up in the answer was that the invention, six months and more prior to the date of the Patent, had been patented to the same party in a foreign country, limited to the term of fourteen years, and that the foreign Patent had expired previous to the assignment. In deciding the case, Mr. Justice Clifford uses the following language:

"Congress, on the 2d of March, 1861, enacted that all Patents hereafter granted shall remain in force for

the term of seventeen years from the date of the issue, and all extension of such Patents is hereby prohibited. Pursuant to that Act of Congress, the Patent in this case was granted to the assignor of the complainants for the term of seventeen years from the 3d of October, 1865, without any limitation whatever. (12 Stats. at Large, 249.) Since then, to wit, July 8, 1870, Congress has provided to the effect that Patents here, previously patented in a foreign country, shall expire at the same time with the foreign Patent, or if there be more than one, at the same time with the one having the shortest term; but in no case shall it be in force more than seventeen years. (16 *Ib.*, 201; Rev. Stats., 4887.) *Granted as the Patent in this case was, under the Act of the 2d of March, 1861, it is clear that it is valid, and it will remain in force for the term of seventeen years from the time it was granted.* (Weston *v.* White, 13 Blatch., 364; Anilin *et al. v.* Hamilton Manufacturing Company, 13 Official Gazette, 273.) Much discussion of the question of infringement will be unnecessary, as the respondents admit that they have been engaged in putting up and selling rolls of braid under the Patent described in the answer.

"Decree for complainants for an injunction and for an account."

In this case it is obvious that Mr. Justice Clifford held that the Patent would expire seventeen years from October 3, 1865, the date of issue of the United States Patent. This is admitted by Mr. Justice Blatchford, who says of this case, in deciding De Florez *v.* Reynolds:

"But Mr. Justice Clifford, in the decision, went on to say that the Patent would remain in force for seventeen years from the time it was granted, because it was granted under the Act of 1861. *He seems to have meant seventeen years from October* 3, 1865."

According to the interpretation of the case of Weston *v.* White, by Mr. Justice Blatchford, it was only necessary for the court to decide, on the motion for a preliminary injunction, "that the Patent had not, under section 6 of the Act of 1839, run out in fourteen years," and, of

course, in citing this decision, Mr. Justice Clifford merely refers to the disposition of the question which it was necessary for the court to decide.

Defendants, in part VIII of their answer, aver that the Reissued Letters Patent of complainants are wholly void, because not expressly limited to a term of seventeen years from the date or publication of the English Patent referred to by them.

That their premises do not in any event justify their conclusion is expressly held in O'Reily *v.* Morse, 15 Howard, 112, which case has never been questioned or disturbed by the United States Supreme Court since its decision.

THIRD.

The bill alleges that "the said defendants * * * in violation of the rights of your orators, and in infringement of said Letters Patent, * * * unlawfully and wrongfully manufacture, construct, and use furnaces embracing in their construction and mode of operation the said invention and improvement," etc.

The defendants answer, "We believe that the Midvale Steel Works, a corporation, * * * has since July 22, 1878, used a furnace embodying substantially the construction and mode of operation specified and claimed in said Reissued Letters Patent, and we admit that we have been directors of said corporation since July 22, 1878," and aver that even if the corporation is liable, they are not in any way liable or accountable.

The question is thus raised whether the defendants, as directors of the Midvale Steel Works, are individually liable for the infringement complained of. It would seem to be not difficult of solution.

That directors of a corporation and its agents are responsible to its stockholders for their nonfeasance and misfeasance on the same general principles that regu-

late the relation of master and servant, is well settled. (Field on Corporations, § 156.)

That the infringement of a Patent is a tort in the nature of a nuisance, is equally so. (2 Hilliard on Torts, 3d Ed., 16)

And so also is the general rule that an agent is equally responsible with his principal for torts committed in the coure of, and within the scope of, his employment.

"The prevailing doctrine is that an action, based even on the negligence of persons doing work, lies against them as well as their employers; that the command of a superior to commit a trespass, or other unlawful act, is no justification to an inferior, * * * and that if one person commit an unlawful act or misfeasance, under the direction of another, that fact will not shield him from responsibility, but both are equally liable to the injured party." (2 Hilliard on Torts, 3d Ed., 457.)

And this doctrine is peculiarly applicable to directors of a corporation, for the reason that inasmuch as they are themselves the efficient and executive head of the corporation, who have practically the full management and direction of its business, and selection and control of its officers and agents, they cannot be permitted to plead their own command to themselves as a protection against liability, for a tort committed under their own direction and supervision. To state the proposition is to answer it.

Speaking of directors, "who in courts of law are viewed as agents of the corporation"—

"He" (*i. e.*, director as agent) "is also liable for trespasses, frauds, or other wrongs which he may commit against third persons while discharging the duties of his agency, or, as the books more briefly express it, for misfeasance, and he is none the less liable for acts of misfeasance from the fact that his principal may also be liable." (Thompson on Liability of Officers, etc., p. 352.)

And these well-known and recognized principles of law have frequently been applied to officers, and even to the stockholders, of corporations found infringing patents.

"A point has been made that the defendants are not liable for the infringement charged, as the only participation alleged in same is as *stockholders* of an incorporated company, which company is engaged in manufacturing and selling the patented article.

"However that may be, it appears that the defendants are either directors of the company, who have the management and superintendence of the business, and under whose direction the articles are manufactured and sold, or are the agents of the same, concerned in conducting the business. On this ground, I am of opinion that they are responsible, and properly made parties defendant." (Per Nelson J., Goodyear *v.* Phelps, 3 Blatch., 91.)

In an action against *stockholders* individually, for an infringement of a patent, it was said:

"The Missouri statute as to private corporations, and the formation of corporations thereunder, cannot be interposed as a shield by the corporators to protect them against wrongful acts. Were this otherwise, then the organization of an insolvent or worthless corporation, in whose name the wrong was done, would enable infringers to destroy the value of a patent and escape harmless." (Per Treat, J., St. Louis Co. *v.* Quimby, 18 Off. Gaz., 571.)

And the remarks of Shipman, J., are peculiarly applicable to the facts as disclosed by the pleadings in this case:

"A preliminary objection is suggested on the alleged ground that the bill does not charge an infringement by the joint acts of the defendants, and it is urged that as the answer shows that the defendants are mere employees of a corporation known as the 'New York Gutta Percha and India-rubber Vulcanite Company,' and that all the acts alleged against them, if any were

done by them, were performed in the capacity of servants of such corporation,—they were, therefore, not the proprietors, or, if the proper parties, are improperly joined in the bill.

"In view of the concealed facts, I do not think these objections are important.

"The allegation in the bill is that the defendants, not using, etc., which, although it might be more specific, is not sufficient in point of form.

"The proof supports the allegation, as it shows that whatever the defendants have done they have done in concert in the prosecution of the business of a single establishment. Indeed, the answer impliedly admits that whatever is done by the defendants is done by them acting together, although they aver that it is not done by them on their own account, but only as the employees of a corporation. I think it appears, from the answer and the proofs, that the defendants are acting in concert in the use which constitutes the alleged infringement of the plaintiffs' rights. The fact that, as between themselves, they are connected together as the stockholders, managers, and servants of a corporation, does not exempt them from the restraints of the injunction." (Per Shipman, J. Poppenhausen *v.* Folk, 4 Blatch., 493.)

Mr. Walker says, in his recent work on patents, page 299:

"The officers of a corporation are the persons who are charged with the superintendence and control of its transactions. It is doubtless their duty to refrain from directing infringements to be committed, and also to prevent the agents and servants of their corporation from committing infringements of patents when prosecuting the corporate business. If such an officer directs and causes a specific thing to be done which turns out to constitute an infringement, it is extremely difficult to see why he should be permitted to shift all the responsibility for the tort upon the intangible corporation; that is to say, upon the innocent stockholders in a body."

CHARLES S. WHITMAN,
For Appellants.

123-276

Office Supreme Court U. S.
FILED.
OCT 7 1887
JAMES H. McKENNEY,
CLERK.

Supreme Court of the United States.

CHARLES WILLIAM SIEMENS
AND
FREDERICK SIEMENS,
Appellants,

vs.

WILLIAM SELLERS,
EDWARD W. CLARK,
JOHN SELLERS, Jr.,
JOSEPH F. TOBIAS,
AND
JAMES A. WRIGHT,
Appellees.

No. 297.
October Term,
1885.

BRIEF FOR APPELLEES.

S. S. HOLLINGSWORTH,
JOS. C. FRALEY,
Of Counsel for Appellees.

CHARLES SIEMENS *et al., Complainants Below and Appellants,*

vs.

WILLIAM SELLERS *et al., Defendants Below and Appellees.*

BRIEF FOR APPELLEES.

This was a suit in equity brought for alleged infringement of reissued letters patent No. 3265, granted to the complainants under date of January 12th, 1869, for "Improved Regenerator Furnace for Metallurgists and others."

The original patent was dated March 1st, 1864.

The defenses may be summarized as follows :—

I. That the reissue had expired by limitation before the alleged infringement took place.

The act alleged to constitute an infringement did not occur until after July 22d, 1878.*

Defendants aver that the Reissue No. 3265, expired on July 19th, 1878, because the invention had been previously patented by the complainants themselves, in British letters patent No. 167, sealed July 19th, 1861, whereby the term of the American patent was limited to seventeen years from that day, instead of from the day of its issue here.†

II. That the act claimed to constitute the infringement is not one for which the persons here sued can be held liable.

The only ground upon which defendants are sought to be charged with infringement is that they were directors of a

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*The only evidence of infringement is the admission contained in the answer. (See Record, pages 5, 9, paragraphs marked "IV.," "V.," and "X.")

†This is duly set up in answer, see Record, page 6, paragraph marked "VI."

corporation which, after July 22d, 1878, used a furnace embodying the patented construction.

I.

THE TERM OF THE REISSUE No. 3265, WAS LIMITED TO SEVENTEEN YEARS FROM JULY 19th, 1861, THE DATE OR PUBLICATION OF COMPLAINANTS' PRIOR BRITISH PATENT.

This defense requires the consideration of two questions, one of fact,—as to the identity of the two patents; the other of law,—as to the status of an American patent where the inventor has obtained a prior foreign one.

FIRST POINT.

THE SUBJECT-MATTER OF THE REISSUE No. 3265 WAS PATENTED IN COMPLAINANTS' BRITISH PATENT No. 167, PUBLISHED AND DATED JULY 19th, 1861.

The American reissue is printed at pages 69, &c., of the Record; the British patent No. 167 is printed at pages 155, &c.; the American original patent is printed at pages 130, &c.

The original and reissued patents are word for word identical, except that the reissue adds to the three original claims a fourth one in the broadest possible terms.

A comparison of the two specifications (see *supra*, page 6) at once discloses the fact that whilst the British patent specifies and shows several applications of regenerator furnaces, and the American only one, yet the construction and mode of operation of that one are described with great particularity in the British specification.

It will be noted that in the drawings of the respective patents some small details vary; different letters of reference are used to designate features substantially the same in each; and in some instances parts are lettered in the one and not in the other, yet; as was well stated by the court below, "Not a "thought is expressed in the American patent that is not to "be found in its English predecessor. Every claim of the "former may as readily be sustained by reference to the spec-

"ifications and drawings of the one as the other." (Record, page 194.)

Against the strong *prima facie* impression thus produced the arguments advanced by counsel are briefly as follows: *First.*—That the American patent, notwithstanding its broad claims, is, in fact, to receive a most narrow construction, limited to certain minute details alleged to be disclosed by *the drawings* (as distinguished from the verbal description), and that therefore its subject-matter is wholly different from that of the British patent. *Second.*—That the furnace which complainants themselves described in their British patent is an inoperative and useless one.

We say advisedly "the argument advanced by counsel," for it is a significant fact that neither of the Messrs. Siemens has ever, by word or deed, countenanced any such theory.

Though they are nominally the complainants, the bill is sworn to and filed by their agents here, who wisely refrain from calling either of the patentees as a witness.

We shall show that not only is this claim without foundation in the language which the inventors have used in this patent, but that it is absolutely negatived by their acts and by declarations elsewhere found of record.

The Invention.

The subject-matter of these patents is that which has placed the Messrs. Siemens at the head of modern metallurgists, and made their names famous in science.

The "Regenerative System," of abstracting the heat from escaping smoke, storing it up, and reimparting it to the fresh air of the furnace blast, though suggested many years ago by Stirling in his hot-air engine, and patented in one form by Du Faur in connection with an iron furnace, was first perfected for practical application to all purposes by the Siemens Brothers.

The first of their patents was taken in England in 1856 by Frederick Siemens, and described a crude apparatus intended both for solid and gaseous fuel. (See this patent, Record, page 75, &c.)

No patent corresponding to this was ever taken by him in America, and it was not until the two brothers had reached the perfected system described in their British patent of 1861, (now under discussion) that they deemed the invention sufficiently mature to justify its protection here. The original American patent of March 1st, 1864 (on which the reissue in suit is based) was absolutely the first one taken in this country by them, or either of them, for any regenerative apparatus.

Apart from anything to be drawn from the language of the document itself, the natural presumption would be that inventors of such a high order of intelligence, enterprise, and wealth would seek to obtain the broadest and most comprehensive claims permissible.

It was their foundation patent for which they were applying, and not merely one for some petty improvement built upon an already existing monopoly.

This presumption becomes a forcible one when we find them, after four years and nine months, applying for a reissue, *which changed not one word of the original, but merely added thereto a *fourth claim in much broader language than any before employed.*

And to leave no doubt as to the inventors' belief in the fundamental character of their first patent, we find Charles W. Siemens, in two patents granted him *in 1877*, using the following language to designate it:—

"My [new] invention relates to *that class* of furnaces known "as regenerative gas furnaces, *for which* letters patent of the "United States were granted on the first day of March, 1864." (Record, page 185 and page 190.)

One of these late patents has even a much more important bearing on the subject, which will be adverted to later on, but

* "We also claim the combination of a furnace with one or more re- "generators or means of receiving its waste smoke and gaseous prod- "ucts, and intercepting or receiving heat therefrom, and also with "means or devices by which all or a portion of the heat so intercepted "or received may be absorbed by the influent air or gas during its pas- "sage into or to such furnace for the purpose of improving or promoting "combustion therein."

the present citation of them is to show, beyond question, that the inventor construed the patent of 1864 as covering, broadly, the regenerative gas furnace.

Comparison of the Two Patents.

In the light of this statement, as to the surrounding facts, we will proceed to compare, in parallel columns, the two documents, premising here that while every word of the American patent (except the statement as to the arrangement of the figures in the drawings), is given below, only a part of the many variations described in the English one is printed.

It should further to be stated that though the American patent claims broadly the furnace for "other purposes" than metallurgical ones, and refers to glass furnaces, &c., at some length, the inventors state that a puddling furnace is the type selected for the drawings and detailed description. In the British patent both the glass furnace and the puddling furnace are described in detail, and illustrated by numerous drawings. The *glass furnace* is however first taken up, and when, later on, the *puddling furnace* comes to be described (page 165), we find short references for details to the previous pages, such as "constructed in a similar manner to those "already described," "in the manner hereinbefore described, "with reference to other arrangements," &c.

Hence, in the citations from the British patent below, it has been necessary to collate sentences from different pages, but in every instance where any other than an absolutely literal quotation is given, italics are used, in order that there may be no misapprehension.

As the patent is quite long it has been found convenient to divide it up in the following manner:—

First.—The general statement of invention.

Second.—The detailed description of the furnace by reference to the drawings.

Third.—The detailed description of the gas-producer.

Fourth.—The claims.

General Statement of Invention.

American Patent.

(Rec. p. 69.)

Be it Known, that we, Charles William Siemens and Frederick Siemens (residents of Great George Street, Westminster, in or near the City of London, of the Kingdom of Great Britain) have made a new and useful invention, having reference to furnaces of various kinds, and we do hereby declare the same to be fully described in the following specification, and represented in the accompanying drawings.

The object of our invention is not only to economize heat, or to save and utilize much of it that is generally wasted by being allowed to escape into and through the chimney of a furnace, but to produce heat by the combustion of gases and atmospheric air in mixture, the gases being derived from coal or other fuel by a furnace such as we shall hereinafter explain, or by any other suitable means or apparatus.

In carrying out our invention in its application to a furnace for puddling iron, or for any other purpose where the furnace is to be heated to a high degree, we arrange four of what we term the "regenerators" below the level of the bed of the furnace, and when all or any of them may be placed immediately underneath the furnace we form underneath the latter a space for the circulation of cold air, the top of the regenerator or regenerators which may be immediately underneath such space being duly covered.

Passages lead from the upper part of two of these regenerators into the furnace, or into a channel or passage communicating with one end thereof.

Similar passages lead from the two remaining regenerators, and in a similar manner communicate with the opposite end of the furnace.

The lower parts of the four regenerators have passages leading into them respectively. To one of the regenerators of each

British Patent.

(Rec. p. 155.)

Now Know Ye, that I, the said Charles William Siemens, on behalf of myself and the said Frederick Siemens, do hereby declare the nature of the said invention (improvements in furnaces), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say:—

These improvements relate to that class of furnaces where regenerators are applied to receive the waste heat of the products of combustion, and to communicate the same subsequently to the air supporting combustion. It is an essential part of our invention that the solid fuel used, such as coal, lignite, peat, &c., should be decomposed in a separate apparatus, so that the introduction of solid fuel into the furnace may be altogether avoided, and the gaseous fuel may be heated to a high degree prior to its entering into combustion with atmospheric air, also heated to a high degree, thus causing a great economy of fuel.

In constructing furnaces for melting glass or for other purposes where a chamber is to be heated to a high degree, we place four regenerators below the level of the bed of the furnaces, and when we place the regenerators immediately underneath the furnace, we form a space for the circulation of cold air between the arches, covering the regenerators and the under side of the bed of the furnace.

Passages lead from the upper extremity of two of these regenerators into the furnace or chamber to be heated at one point or extremity, while

Similar passages lead from the two remaining regenerators, and communicate with the heated chamber at another point, the passages uniting upon entering or shortly before entering the furnace.

The lower extremities of the four regenerators communicate with valves or reversing dampers, by means of which currents

AMERICAN PATENT.

pair, at either end of the furnace, the passage leading into its lower part is to open into the atmosphere so as to supply the regenerator with atmospheric air. The passage leading into the lower part of the other regenerator of the pair is a gas-conduit for supplying its regenerator with gas. The several passages communicate with a flue or chimney, and have valves and reversing-dampers, by means of which currents of air and combustible gas or gases may be directed through the furnace and the whole system of regenerators in the following manner:—

A current of air is to be caused to flow into the lower part and up through one of the regenerators of one of the two pairs of them. At the same time a current of gas is to be made to flow into the lower part of the other regenerator of such pair. After ascending through their regenerators, or between the bricks of the mass of loosely-piled brickwork or other refractory material making part of such regenerator, the said aerial and gaseous currents unite and flow into the furnace, where they are to be fired. The heated volatile products or spent gases resulting from the combustion of the said currents of air and gas will flow out of the furnace and into and down through the two remaining regenerators, and after circulating through the masses of brickwork or refractory material of which such regenerators are composed in part, the said spent products will be directed into and will escape by the chimney. When the last two regenerators may have been sufficiently heated, the direction of the aerial and gaseous currents is to be reversed—that is to say, the currents of air and gas are to be caused to enter the two last-mentioned regenerators separately—that is to say, air is to pass into one and gas into the other. In ascending through the regenerators the air and gas will be heated, or will absorb from the masses of brickwork much of the heat previously imparted to them, after which the two currents will unite and flow into the furnace, and there will be inflamed, and will produce a flame of very great intensity or heat. The spent products of combustion will flow out of the furnace and thence down through the remaining two regenerators, and after imparting their heat to them, or having it more or less abstracted by them, will be directed into and caused to escape by the

BRITISH PATENT.

of air and the combustible gas which we employ are directed through the whole system of regenerators and furnace in the following manner:—

A current of atmospheric air enters through one of the valves with one of the four regenerators at the bottom, while a current of gas is directed into a second regenerator. The two currents ascend through the masses of loosely-piled brickwork or other refractory material of which the regenerators are composed, and unite on entering the heated chamber or furnace where they are fired.

After having traversed the furnace the products of combustion pass downwards through the two remaining regenerators, imparting heat to the same, and are thence directed into a chimney.

When the two last-named regenerators have been heated sufficiently, the direction of the currents is reversed.

Currents of air and gas are made to enter these two regenerators separately, and are heated in ascending through them; and when these heated currents unite at the point of entrance into the furnace they produce an intensely hot flame.

* * * * * the hot products of combustion, after traversing across the furnace, will pass down at C^1, through the regenerators B^3 and B^4, imparting to these the greater part of their heat, and thus each pair of regenerators will alternately serve to absorb the heat from the products

AMERICAN PATENT.

chimney. The supplying aerial and gaseous currents are thus to be thrown through the pairs of regenerators alternately, their combustible products escaping through the discharging pair and serving to heat them, while they in turn serve to heat the aerial and gaseous currents when caused to flow through them (~~fig. 1, p. 2~~).

[Here follows the literal description of the gas generator, which will be noted later.]

By means of the gas-generator, or, in other words, by decomposing the solid fuel, such as coal, lignite, peat, &c., by means of a separate apparatus, we not only avoid the introduction of such fuel into the furnace, but we are enabled to heat the gas to a high degree, and to mix it with heated air preparatory to its being conducted into the furnace or place designed for its combustion and to be heated thereby. By the absence of any solid carbon, or ashes in the working-chamber of the furnace operations may be carried on in an open furnace, which hitherto has only been possible to conduct in covered vessels or pots.

Thus we can melt flint, extra white, and other superior qualities of glass in open pots, fire-pottery, without enclosing the same in "saggers," or melt steel and other substances upon an open bed or hearth without injury.

It is also important in many operations that the state of pressure of the gases in the furnace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmosphere, in order to prevent the egress of flame from or the ingress of air into the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass or puddling iron.

For this purpose we arrange with the furnace four regenerators, as hereinafter described, and to operate * as before specified.

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of combustion, and then give off this same heat again to the gas and air serving to produce this combustion.

It is an essential part of our invention that the solid fuel used, such as coal, lignite, peat, &c., should be decomposed in a separate apparatus, so that the introduction of solid fuel into the furnace may be altogether avoided, and the gaseous fuel may be heated to a high degree prior to its entering into combustion with atmospheric air, also heated to a high degree, thus causing a great economy of fuel. There is also a great advantage derived from the absence of any solid carbon or ashes in the working-chamber of the furnace, by which we are enabled to carry on operations in the open furnace, which it has only been possible hitherto to conduct in covered vessels or pots.

We are thus enabled to melt flint, extra white, and other superior qualities of glass in open pots, to fire pottery without enclosing the same in saggers, or to melt steel and other substances upon an open hearth or bed without injury.

It is also important in many operations that the state of pressure of the gases in the furnace should be under entire control, and should sometimes exceed, and at other times exactly balance, that of the atmosphere, in order to prevent the egress of flame from, or the ingress of atmospheric air into the furnace on opening apertures for the approach of the workmen attending the operation to be carried on, such as blowing glass, puddling iron, &c.

For this purpose we arrange four regenerators below the bed of the furnace, two of which serve to communicate heat separately to the combustible gases and atmospheric air on their way to the furnace, and the remaining two to absorb the waste heat from the products of combustion passing through them indiscriminately before reach-

* See page , *supra*.

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In some cases, however, where no great heat may be required, or where the gas may be very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages substituted, but we generally prefer the employment of the four regenerators.

In applying our improvements to glass furnaces, we find it sometimes advantageous to melt the materials composing the glass in open pots, and to cover the latter with movable lids while working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces—for instance, to heat annealing-furnaces or "lears" in the manufacture of glass—we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire-clay or other refractory material are to be provided in that case to these channels to regulate the flow of the gases, according to the direction in which the main furnace may be working, or we draw off the mixed gases, in a state of combustion, from the principal furnace.

In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces, side by side, and only one set of four regenerators, which, by means of slides or valves of fire-clay or other proper refractory material, can be made to communicate at intervals with one heated furnace or the other. During the time that one furnace is fired the other is to be allowed to cool, to be discharged and charged again with fresh material, and *vice versa*. The regenerators may thus

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ing the chimney (their respective action being reversed at intervals), the currents of heated gas and air in ascending through and from the regenerators into the furnace causing a plenum of pressure within the same, which is capable of being modified or regulated by valves for the admission of the gas and air to the regenerators and by the chimney damper. By the same arrangements the chemical qualities as well as the intensity of the flame can be regulated to the utmost nicety.

In some cases, where no great heat is required, or where the gas used is very rich in combustible matter, the two regenerators intended for heating the combustible gases may be suppressed and mere passages be substituted, but we generally prefer the four-regenerator arrangement.

In applying our improvements to glass furnaces we find it sometimes advantageous to melt the materials composing the same in open pots, but to cover them with movable lids whilst working the metal out in the usual way. When it is required to accomplish secondary operations in separate furnaces, for instance, to heat annealing furnaces or lears in the manufacture of glass, we accomplish this without providing separate regenerators, but by arranging branch channels leading from the upper portion of the four regenerators to the lear or furnace to be heated, where they join in combustion. Dampers of fire-clay or other refractory material are provided in that case to these channels to regulate the flow of the gases according to the direction in which the main furnace is working; or we draw off the mixed gases, in a state of combustion, from the principal furnace.

In firing pottery ware, in calcining ores, and other operations, it is required that the furnace charged with these materials, after having been heated to the desired degree, should cool gradually and completely before it is charged again. In such cases we propose to provide similar furnaces side by side and only one set of four regenerators, which, by means of slides or valves of fire-clay or other refractory material, can be made to communicate at intervals with the one furnace or heated chamber or the other. During the time that one furnace is fired the other is allowed to cool, to be discharged and charged again with fresh material, and *vice versa*. The regenerators are thus

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always be kept in working condition. Or we arrange four or more chambers in such way that they themselves may contain the materials to be fired, and serve alternately as regenerators and as kilns, to be fired or discharged.

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always kept in working condition. Or we arrange four or more chambers in such a way that they themselves are made to contain the materials to be fired, serving alternately as regenerators and as kilns, to be fired or discharged.

PARTICULAR DESCRIPTION OF FURNACE.

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In the *drawings (Figs. 1, 2, 3, 4, 5, 6, and 7),

A is the furnace, of which

a is the bed,

b the crown or arch, and

c the mouth.

Beneath the bed of the furnace are the four regenerators B^1, B^2, B^3, B^4, each consisting in part of a chamber erected of fire-brick or other refractory material, and having

A grating, c^1, extending across its lower part and constituting part of the upper portion of an arched passage, H I K L, arranged underneath such chamber.

Upon this grating is a pile, *d*, of fire-bricks or other heat-absorbing and indestructible materials, the same being arranged or stacked in such manner as to leave interstices or spaces between them, so as to enable the air or gas while passing through the pile to come in contact with the surfaces of the several parts of the bricks thereof.

Each of the said regenerators is arched or closed over at its top and opens into the furnace by a passage, *e*, leading out of it and into a common passage, *f* or f^1, as shown in the drawings. The two passages ff^1 lead out of the furnace A in opposite directions and from opposite ends thereof.

Directly underneath the bed of the furnace A, and between it and the tops of the two inner regenerators B^2 and B^3, there is

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In Figs. 11, 12, 13 is shown a construction of our improved regenerative gas furnace adapted for the purpose of puddling iron.

The bed A of the furnace B is made of considerable depth, and is constructed of iron covered with fire-brick or other refractory material.

Beneath the furnace are the regenerators C^1, C^2, C^3, C^4, constructed in a similar manner to those already described, viz., each consisting of a chamber built of fire-brick, near the bottom of which is grating c^1 c^2 c^3 c^4.

Upon this grating are piled the fire-bricks or other refractory material d^1 d^2 d^3 d^4, in such manner as to leave small interstices between each brick ([illegible]).

We arch over the regenerators in such a manner that the gases unite only near the point where they enter the furnace, at which place they rise up between perpendicular walls.

* * * * * if gas is entering at the bottom of the regenerator C^3, and atmospheric air is entering at the bottom of the regenerator C^4, they become heated on passing through the masses of loosely-piled bricks; arrived at the top they pass up through the passages J and K, and into the furnace through the side openings J^1, K^1; †there they unite.

In order to prevent an accumulation of excessive heat in the arch covering the regenerators, and forming at the same time

* Previously described as "views of a puddling furnace with our said invention applied "to it."

† Fig. 12, sheet 2, passages L M at one end of the furnace, and passages J K at the outer end of the furnace, lead into the furnace as indicated by the arrows. They respectively open into the furnace from a common chamber, through passages leading out of the furnace in opposite directions and from opposite ends thereof.

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an air chamber or space C, which should communicate freely at its opposite sides or ends with the atmosphere, in order that a current of *cool* air may be caused to continually pass through it for the purpose of maintaining the bed of the furnace, as well as the arches of the regenerators B^2 B^3, at a low temperature, and thus protect them from being destroyed by the intense heat within the furnace and regenerators while they may be in operation.

In rear of the upper parts of the regenerators and below the furnace there is an air space or chamber D, which at intervals is bridged as shown at *g g g*.

There is also below the space D a sunken space or chamber E, in which are situated the levers for working the dampers of the apparatus.

In front of the space E there is a passage, F (see Fig. 6), which continues horizontally in opposite directions, and thence drops downward, and at its two extremities opens into the two passages H and L,

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the support of the furnace bed, we provide chambers between the same for the circulation of atmospheric air.

Below the bed spaces *a a a* are provided for the circulation of cold air.

This (the bed of the furnace) consists of a number of slabs of fire-clay or other refractory material, having on their under side small channels, *e e e*, communicating at one end through the channel *f* with the atmosphere, and at the other end with the air passage I, conducting to the regenerators. A current of cold air is continually passing through these channels, tending to maintain the bed of the furnace and the arches covering the regenerators at a low temperature.

* The regenerators B^2 and B^3 communicate alternately with the passage I, leading to the atmosphere. [*Note.—Though not specified as bridged or arched, this space I is so shown in Fig. 3, Sheet 1; also, a similar space, without any letter, is shown in Fig. 11, Sheet 2, above the valve D. The space (corresponding to E) in which the valve handles work, is not lettered, but plainly and necessarily shown.*]

Each of the regenerators B^1, B^2, B^3, B^4. [NOTE.—*The outermost ones being* B^1 *and* B^4], are provided below the gratings with openings F^1, F^2, F^3, F^4. [NOTE.—F^1 *and* F^4 *are below* B^1 *and* B^4.] * * *

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* Testimony of Coleman Sellers. Rec. page 90.

6 *Question.* In the English Patent of complainants, No. 167, of 1861, do you find any equivalent for or of the air-chamber or space D, or the same and the space E, combined with the furnace, regenerators, conduits, and damper-chests applied thereto, substantially as specified in the Reissue 3265, *and referred to in the third claim thereof?* If so, please point out the same in said English Patent.

Answer. In the American Patent the description of *the functions of chamber D* contains in said description the assertion that *there exists within such chamber a damper-case R*, arranged vertically, and having a damper S', arranged within it so as to be capable of being turned by lever H. Referring to Sheet 2 of English Patent above referred to, No. 167, Figure 11, *shows a damper-case marked D in this drawing*, and having its damper, D, capable of being turned by a lever, *d; above the valve D, or damper-case containing valve D, there is an arched space equivalent to the chamber D in the American Patent, whilst the reversing lever d is situated in a chamber extending below the one just alluded to*, and being equivalent to that portion of the American Patent drawings where such space is indicated by letter E. Again, in Sheet 1 of English Patent No. 167, in Figure 3, this space equivalent to D in American Patent is indicated by the letter I. It is shown to be arched over in the drawing, and *serves the same purpose*, of containing the damper-case and admitting air to the damper-case marked *h*, the valve of which is operated by a lever, Z, in a space equivalent to E in the American Patent drawings, and being arranged for the same purpose. In this drawing, that I is in free communication with the atmospheric air is not only indicated in the description of the drawing, but the passages *e*, equivalent to passages C in the American drawing, and designed to allow free passage of air between the bed of the furnace and the crown of the arches of the regenerator, are shown to be in communication with this chamber I.

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which extend underneath the two outermost regenerators.

Each of these passages H I K L is to be closed at both of its ends, but the two middle passages I K are shown in Fig. 4 as open at their rear ends.

These middle passages, however, with vertical continuations of them leading into a horizontal passage, N, are, as well as the said passage N, to be walled up or covered in rear.

The same may be said with respect to a gas tube or passage, O^1, which is to lead from the *generator* and into the passage N, as shown in Figs. 3 and 4.

Between the two passages I K there is a smoke flue, P, into the rear part of which there is an opening, ~~f~~, leading from the passage F, or a damper-case arranged vertically therein, and having a damper, S^1, arranged within it and so as to be capable of being turned by a lever *h*.

There is another such damper-case, T^1, applied in the passage N and opening at its opposite sides into such passage and also at its top into the generator-conduit or gas flue O^1.

Within the case T^1 there is a damper U, capable of being turned by a lever, *i*.

Situated over each of the damper-cases there is a valve opening, V^1 or W^1, provided with a valve, X or Y, the whole being arranged as shown in Figs. 3 and 4.

The valve Y will serve to arrest the flowage of air into the passage F (the cold-air channel).

So with the valve X, it will answer to close off the passage of gas into the damper-case immediately underneath it (in the gas-channel).

By means of the damper U, gas from

BRITISH PATENT.

Gas from the generator will pass through the passages J J and will enter the regenerator B^4 through the aperture F^4. * * * Arrived at the other end of the furnace the hot products of this combustion pass downwards * * * into the regenerators B^1 * * * and they issue in a comparatively cold state through the passages F^1 * * * into the passages K K. [NOTE.—*Referring to Fig. 4, Sheet 1, it will be seen that the passages J J and K K continue horizontally in opposite directions, and thence drop downward, and at their outer extremities open into the passages, F^1 and F^4, which extend underneath the two outermost regenerators.*]

Openings F^1 * * * F^4, by means of these the generators B^1 and B^4 communicate * * * with the passage H leading to the chimney. These * * * communications are regulated by the reversing valves or dampers *g*, *h*. [NOTE.—*H is the smoke-flue, and in Fig. 4 Sheet 1, it is shown to be between the two passages F^1 F^4. The opening from H leads from the damper-case arranged vertically in the passage I (which is the fresh air passage). This damper-case has a damper h arranged within it and so as to be capable of being turned by a lever Z.*]

The horizontal pipe U, * * * establishes a communication between all the gas-generators, and the regenerators B^1 and B^4. This pipe descends again at U^1, where it joins on to the flue G.

The regenerators B^1 and B^4 communicate alternately with the passage G, leading from the gas-generators. * * * These alternate communications are regulated by the reversing valves or dampers *g* and *h*. [*Note.—The damper-case of damper g is applied in the passage G and opens at its opposite sides into such passage and also at its top into generator-conduit or gas flue U^1. See Fig. 3, Sheet 1.*] Dampers *g*, *h*, are reversed by means of the levers Z Z.

The currents of gas and air in ascending through and from the regenerators enters into the furnace, causing a plenum of pressure within the same, which is capable of being modified or regulated BY VALVES for the admission of gas and air to the regenerators, AND by the chimney damper. By the same arrangements THE CHEMICAL QUALITIES, as well as the intensity of the flame, can be regulated to the utmost nicety.

By means of the reversing valves or

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the passage O^1 may be led into either of the passages I K, it being cut off from passing into one while it may be passing into the other.

So, by means of the damper S^1, air may be caused to flow *ad libitum* into either of the passages H L, it being cut off from one while it may be passing into the other.

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dampers D, E, actuated by the levers *d*, *e*, the regenerators C^1 and C^3 are made to communicate alternately with the gas generators through the passages F and G, and with the flue Z leading to the chimney, whilst the regenerators C^2 and C^4 are made to communicate alternately with the atmosphere through the passages H and I, and with the chimney through the flue Z. [*Note.—See Figs. 11, 13, Sheet 2.*]

THE DESCRIPTION OF THE GAS-GENERATOR.

Although there is no claim in the American patent for this portion of the subject-matter described, it is instructive to see how the identity of the two specifications extends even to the details of this apparatus.

AMERICAN PATENT.

Before proceeding to more fully describe our invention we (referring to Fig. 5, Sheet 1) will explain a gas-generator such as may be employed in connection therewith, the said generator being shown in vertical section in Fig. 8.

One or more of these generators may be used in connection with a conduit or conduits for the conveyance of gas to the regenerators.

In this gas-generator O is a hopper or induct, into and through which the coal or fuel is to be introduced, the said hopper being closed by means of a cover, *a*, after it may have received a supply of fuel. From the hopper the fuel descends an inclined plane, P, composed of fire-brick or other proper refractory or heat-resisting material, it being inclined at an angle of about forty-five degrees to the horizon. From thence the fuel passes upon a fire-grate, Q, having a less inclination.

Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, there is an arch, R, of fire-brick.

This arch, after having been heated to a considerable degree by the fire on the grate, will radiate heat on the fresh fuel while it may be passing down the plane P, and thus will aid in causing the decomposition and volatilization of the fuel, which will be afterward completed by the fire in the furnace and by the atmospheric air which may enter through the grate Q.

BRITISH PATENT.

The combustible gases are produced in a series of gas-generators, N, N, by the imperfect combustion of fuel.

* * * * * If several generators are provided, we prefer to lead the gases produced by them into a main channel, which may be arranged to supply several furnaces * * * * *

In these gas-generators the fuel is introduced through the hoppers O, kept closed by means of the covers *o*, *o*; from these hoppers the fuel descends on to an inclined plane P, of fire-brick or other refractory material, which may be inclined about 45 degrees: thence the fuel passes on to the fire-grate Q, which should be inclined about 30 degrees.

Over this grate, but at a sufficient height from the same to allow a deep layer of fuel to intervene, is an arch of fire-brick R.

This arch, being once heated to a considerable degree by the fire on the grate, radiates heat on to the fresh combustibles as they pass down the inclined plane P, and thus causes their partial decomposition and volatilization, which is afterwards completed by the atmospheric air which enters through the grate Q.

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The air, on passing through the highly-heated fuel lying upon the grate, will be decomposed into carbonic acid gas, with a certain proportion of nitrogen. Afterward, on passing up through the thick layer of fuel in a less state of combustion or incandescence, it will become transformed into carbonic oxide, and in this state will pass over the surface of the fuel resting on the plane P, where it will mix with the gases evolved from the same, and finally escape by the passage S, and into the vertical pipe T, leading into the conduit U, by which it will be conveyed to the regenerators.

The aperture V at the top of the generator is to enable a person to introduce a poker into the fuel for the purpose of stirring it from time to time. A valve, *w*, in the pipe T answers to close the latter as occasion may require. By means of a pipe, *k*, leading into a conductor, *i*, water may be led into the generator in a small stream. This small current of water, falling on the fuel, becomes vaporized. The vapor, acting on any hot particles of carbon rising up with the gases, will combine with the same and form two combustible gases, viz., carbonic oxide and hydrogen.

We do not confine our invention to the employment of this specific form or kind of gas-generator, as there may be others which may be employed to good advantage, the whole depending on circumstances.

BRITISH PATENT.

This air, on passing through the layer of highly-heated fuel lying upon the grate, is first decomposed into carbonic acid gas with a certain proportion of nitrogen, and afterwards, on passing up through the thick layer of fuel in a less state of incandescence, it becomes transformed into carbonic oxide, and in this form passes over the surface of the fresh fuel on the inclined plane P, where it mixes with the gases evolved from the same, and then passes up through the passage S into the vertical pipe T, and from this into the horizontal pipe U, which establishes a communication between all the gas-generators and the regenerators B^1 and B^4.

An aperture V is formed in the top of the generator for the purpose of stirring the fuel from time to time. Valves *w* are provided in the pipes T of each gas-generator so as to shut off the communication with any one of them when not in use or under repair. A small water supply pipe *k* is provided with little branches and taps for admitting a small driblet of water into the gas generator through the funnel *l* on the pipe T; this small current of water passing along the side of the pipe, and falling partially on the body of the fuel, becomes vaporized, and the vapor thus formed, acting upon any hot particles of carbon rising up with the gases, combines with the same, forming two combustible gases, namely, carbonic oxide and hydrogen.

The gas generator just described is particularly adapted for dry coal. In Figures 6 and 7 is shown an arrangement of the same which we prefer employing where very gaseous or "baking" coal is used. The general construction is in most respects similar to the just described one. [*Here follows a detailed description of another form.*]

THE CLAIMS.

In accordance with a very general custom, the British patent claims in one paragraph *all the "various arrangements,"* there being no such particularity required as is the case under our statute.

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The operation of the said apparatus having been hereinbefore substantially described, we now proceed to point out what we claim as our invention, that is to say,

BRITISH PATENT.

Having now described the nature of our invention, and the best modes we are acquainted with of performing the same, we wish it to be understood that we

AMERICAN PATENT.

We claim, in combination with a furnace, A, and its chimney or smoke-discharge flue, P, a system or series of air and gas regenerators, B^1, B^2, B^3, B^4, constructed substantially as specified, and having conduits and dampers arranged so that air and gas may be led into and through such regenerators and furnace, and out of the chimney, in manner and so as to be operated as and for the purpose or purposes hereinbefore described.

We also claim the arrangement and combination of the air-space or open chamber C, with the furnace and its system of regenerators, arranged and applied together, substantially in manner and so as to operate as described.

We also claim the arrangement and combination of the air-chamber or space D, or the same and the space E, with the furnace, regenerators, conduits, and damper-chests applied thereto, the whole being substantially as specified.

We also claim the combination of a furnace with one or more regenerators, or means of receiving its waste smoke and gaseous products, and intercepting or receiving heat therefrom, and also with means or devices by which all or a portion of the heat so intercepted or received may be absorbed by the influent air or gas during its passage into or to such furnace, for the purpose of improving or promoting combustion therein.

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do not confine ourselves to the precise details shown on the accompanying Drawings; but

We claim as our Invention the various arrangements of regenerative furnaces worked by the gases resulting from an imperfect combustion of solid fuel in separate places, as hereinbefore set forth.

While ordinarily the question of identity in subject-matter of the two patents might be considered as belonging to the province of evidence rather than of construction, yet as the real inquiry is as to the scope of the reissue's claim, we might well rest with the verbal comparison of two documents written by the same hand and professing to be, generally, *in pari materia.*

To set all doubt at rest, however, defendants offer the testimony of two witnesses, who are experts not in the ordinary patent-soliciting sense of the term, but through intimate knowledge of this branch of metallurgy.

COLEMAN SELLERS (Record, page 84) gives in his answers to questions 5 and 6, (pages 89–91), a comprehensive analysis of the two specifications, which must be read *in extenso.*

THEODORE BERGNER (Record, page 109) states more briefly the same conclusions.

COMPLAINANTS' THEORY AND OBJECTIONS.

Although the ingenuity of counsel has multiplied the forms of statements, so as to apparently present a number of differences, they are really all reducible to this:—

First.—That the American patent provides for a more perfect mixture of the heated air and gas by introducing the air behind or above the gas instead of side by side.

Second.—That the American patent describes and shows in detail, regulating valves which are not *shown* in the British drawings.

Third.—That the American patent contains a better device for cooling the bed of the furnace.

It is not and could not be pretended that the British patent ignores these important points altogether, but that *better results* are given by the American device.*

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* Thus, upon the first point. The British patent repeatedly points out the manner of mixing the air and gas. Thus the air and gas "on rising up "between the vertical division walls, i^1 i^1, they will *unite*," &c. Again: "Arrived at the top they pass up through the passages J and K, and "into the furnace through the side openings J^1 K^1, here they unite," &c. Again: "On emerging from them at the point C will mix," &c.

Upon the second point. The British patent states "dampers are pro-"vided in the cold air and gas channels, by which the *quantity* and *qual-"ity* of the flame can be regulated to the utmost nicety."

And again: "The currents of heated gas and air in ascending through "and from the regenerators into the furnace cause a plenum of pressure "within the same, which is capable of being modified or *regulated by* "*valves* for the admission of the gas and air to the regenerators, and by "the chimney-damper. *By the same arrangements the chemical quali-*

The real questions, therefore, are whether the points of difference are material, and if so, whether the American patent points them out and claims them as the substantial features of invention.

Here we quote in full an answer of Mr. Coleman Sellers (Record, page 108).

"*Re-ex.* 60 *Question.* You have been asked in cross-exam- "ination as to various differences between the Reissue 3265 "and the English Patent 167. Do you find any of these dif- "ferences particularized in the specification of the Reissue "3265, or designated as material or as essential to the con- "struction or operation of the improvements specified in the "claims of the Reissue 3265?

"*Answer.* I do not. The description of a furnace illustrat- "ing the invention, appended to or making part of the United "States Patent, is the description in detail of a furnace figured "in various views, and is only such a description as will ena- "ble one skilled in the art to understand the various parts "and functions of the parts combined in the one illustration; "but I find no word to indicate any reason why the general "arrangement should not be varied to an unlimited extent so "long as with the combination of furnace there is arranged a "series of regenerators or means of receiving its waste smoke "and gaseous products, or intercepting or receiving heat "therefrom, and also some means or devices by which all or "a portion of the heat so intercepted or received may be ab-

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"*ties as well as the intensity of the flame can be regulated to the utmost* "*nicety.*"

Upon the third point. "In order to prevent an accumulation of ex- "cessive heat in the arch covering the regenerators, and forming at the "same time the support of the furnace bed, we provide chambers be- "tween the same for the circulation of atmospheric air."

And again: "These regenerators are arched over at the top, and sup- "port the bed *a* of the furnace. This consists of a number of slabs of "fire-clay or other refractory material, having on their under side small "channels *e*, *e*, *e*, communicating at one end through the channel *f* with "the atmosphere, and at the other end with the air passage I, conduct- "ing to the regenerators. A current of cold air is continually passing "through these channels, tending to maintain the bed of the furnace and "the arches covering the regenerators at a low temperature."

"sorbed by the influent air or gas during its passage into or "to such furnace, for the purpose of improving or promoting "combustion therein, by which it is necessary that, in connec- "tion with a chimney or smoke-discharge flue, there shall be "a series of air and gas regenerators, having conduits and "dampers arranged so that gas may be led through such gas- "regenerators and furnace and out of the chimney, and that "certain air space be provided between the bottom part of the "furnace and the upper part of the regenerative system, "wherein there shall be a free circulation of cool air, and "there shall be some air-chamber to admit air to the damper- "chest, and some means of working the damper or damper- "chest, and that all these parts be constructed substantially "as described; but I do not find why one or another arrange- "ment of the various parts or devices necessary for the com- "plete carrying out of the principles of the invention which "might suggest themselves to the user of the invention, in "reference to any specific furnace, or to the particular furnace "figured, would be better or worse."

Taking up the objections in order, we reply:—

Answer to First Objection.

There is no suggestion of substantial difference in the method of admixture of the air and gas.

The British patent shows two arrangements for effecting the mixture. The first of these (the glass furnace) introduces the air and gas through five passages, close together, and *alternately arranged*, three for gas and two for air. They mix whilst rising up from the floor of the furnaces. The second arrangement (the puddling furnace) shows them entering side by side, and in only two streams instead of five.

There is no suggestion of any reason for this difference of detail, and the American patent is equally silent as to any advantage to be derived from the third variation which it happens to show.

Apart from any other evidence, these facts would satisfy

the mind as to the purely accidental character of the difference, and thus the court below found the fact to be.

But one of the inventors has, by his express declaration of record, set the matter absolutely at rest.

In an American patent dated August 28th, 1877, Reissue No. 7863 (Rec., page 184), Charles William Siemens, one of the complainants, states:—

"My invention relates to that class of furnaces known as "regenerative gas-furnaces, for which letters patent of the "United States were granted on the first day of March, 1864*; "and the nature thereof consists, first, * * * *secondly, in "the arrangement of the flues leading from the regenerators to "the furnace, whereby the heated air is introduced into the fur- "nace at a level superior to that at which the gases enter."

He continues:—

"In order to render these advantages thoroughly available "for metallurgical furnaces, to produce a heating flame of the "proper length and direction, to mix the air and gas at the "very point at which the heat is required, or where it is taken "up at once by the materials to be heated or fused, to throw "the most intense heat upon the charge, * * * * * * *

"I have found by actual experiment *that a regenerative gas-* "*furnace different in construction and operation from that here-* "*tofore patented by myself and Frederick Siemens is necessary.*" * * *

He says, "And I prefer to cause the air to enter the heat- "ing chamber above the gas, as by its superior specific gravity "at equal temperatures it tends to sink through the gas, and "thus an intimate mixture and more perfect combustion are "obtained."

And he claims:—

"2. A regenerative gas-furnace *in which the air is introduced* "*at a level superior to that at which the gas enters*, as and for "the purposes described."

In other words, we find one of the inventors in a patent dated *thirteen years* later than that in controversy, elaborately describing and claiming as his subsequent and sole invention,

* The patent in suit.

the improvement upon which complainants' two experts lay the greatest stress as distinguishing the Reissue 3265 from the English patent of 1861.

It would seem incredible that Mr. Siemens himself does not understand this system better than anybody else; and when we find him stating this as one of the distinctions between the joint patent of 1864 and his sole patent of 1869, and claiming it as constituting one of the specific differences "*in construction and operation*" between the two, it may well be believed that the court will hesitate to recognize this as a feature of the Reissue No. 3265, upon the authority merely of two experts who do not find in the Reissue 3265 any better support for their opinion than a part of the first claim in connection with the drawings.

Waite, Rec., page 27, × QQ., 153–155;
Benjamin, Rec., page 62, × Q., 83.

Answer to Second Objection.

Regulating valves are specified in the British patent.

As before observed (*supra*, page 16), the necessity for such valves is stated at length in the specification, and the common knowledge of a metallurgist would unquestionably suffice to properly construct and place them.

Here again, however, we are not left to depend upon inference. In the patent of Du Faur, dated January 23d, 1845 (Record, page 175), which has before been mentioned as showing a very early embodiment of the Regenerative Principle, there is the full description and detailed drawing of these regulating valves, and a description of the exact functions now claimed by complainants' experts as characteristic of the American patent in suit.

We quote: "P, P, P, P, is a system of hot-air pipes placed "in the chamber L, L, adjoining the stack E, and communi- "cating with it by means of numerous openings, *l'*, *l'*, *l'*, *l'*, left "in the brick partition that separates the chamber from the "stack. *The burnt gases in their passage out of the stack commu- "nicate sufficient heat through these openings to the pipes to heat*

"*the blast to the required temperature, say from 300° to 500°* "*Fahrenheit.* The pipes P, P, communicate with the hot-air "chamber B through the pipe P', *which is provided with a valve,* "*O, for the purpose of regulating the quantity of air for the com-* "*bustion of the gases.* * * * N is a valve *by means* "*of which the quantity of gases* to be admitted to the refinery "*is regulated.* * * *

"*It is important,* in order to avoid as much as possible the "loss of metal by oxidation during the process of puddling, "*to admit only such quantity of air* through the blow-pipes as "is necessary to produce the perfect combustion of the gases, "of which the workmen can readily judge by the state of the "furnace which is cooled by an excess of air.

"On the other hand, an *excess of gas must also be avoided,* as "it tends to retard the process of decarbonization; this is "readily perceived by the escape of flame from the furnace-"stack.

"The same precautions must be observed with all other "gas-furnaces employed in the different processes of manu-"facturing iron."

The full details of each valve are clearly shown in the drawings.

Here then is the exact device, shown sixteen years before the British specification, and applied for the exact purpose in question, to a regenerative furnace.

It is not seen upon what possible ground it can be argued that invention would be required to place these same valves upon the particular regenerative furnace of the British patent.

Answer to Third Objection.

The provision for cooling the furnace-bed is fully set forth in the British patent.

No less than six explicit statements as to the nature and objects of the cooling passages occur in the British patent, and different arrangements of them are shown and fully described in connection with the respective types of furnace.*

* See page 11, *supra,* for the description of the preferred form in a puddling furnace.

It is true that they are *shown* as arranged in a series, side by side throughout the furnace-bed, while in the American patent they are merged into a single air-chamber or broad passage, but there is not one word tending to throw any stress upon the supposed difference. Even if there be any gain in degree of efficacy from such a detail of construction, no one would be led to infer it from reading the patent, but would be left to find out by experiment how large the passage ought to be.

Complainants' experts have sought to enforce their theory of difference on all three of these points by the sweeping statement that the furnace of the British patent would be inoperative and useless.

This opinion is expressed by the witness, C. R. Waite (Record, page 10, Q. 9), and his reasons are as follows :—

"*Question.* Please give your reasons for your last answer.

"*Answer.* First, an inadequate supply of air supplied for "combustion; no means of regulating the amount of air and "gas admitted to the furnace, and an imperfect mixture of "same in combustion chamber; three separate reasons."

Upon cross-examination it turns out that the first of these reasons is based upon the extraordinary supposition that the drawings *are made to a scale.* (See Record, page 21.)

"*Answer.* In the English Patent I see no drawing in which "the air supplied to the furnace is of sufficient quantity to per- "form the work required of that furnace.

×108 *Question.* How do you get at that conclusion?

Answer. The English Patent, Sheet 1, Figure 3, represents the only furnace, or view of furnace, in which the air-valve and its supply-chamber, with its passage, is shown. In this view the passages are too small for the proper supply of the air required by the furnace.

×109 *Question.* In saying that, do you assume the drawing which you refer to, to be made to a scale?

Answer. I suppose it to be. I take it to be made to a scale, or very nearly to a scale.

×110. *Question.* Do you base your conclusion, as to the insufficiency of the supply, that the drawing is made to a scale?

Answer. I base it upon that, and also upon the relative size of the flues and passages for the admission of the gas, as shown on the figure referred to.

×111 *Question.* Upon that assumption, how do you determine your opinion that the air supply is insufficient?

Answer. With the means I have at my command to measure the size of these openings, marked *e*, through which the air has to pass before entering the valve; their total area, as compared with the area of the valve, is a trifle over one-fourth.

"× 112 *Question. What should the area be for practical* "*working?*

"*Answer.* In a furnace where the air is heated before reach-"ing the valve, *it is impossible to estimate the proper area of the* "*valve without first knowing the temperature of the air to be ad-*"*mitted.*

"× 113 *Question. Who is to make that estimate in construct-*"*ing a furnace for any purpose whatsoever?*

"*Answer. That estimate could not be made accurately by any* "*one*, without first knowing the temperature of the air to be sup-"plied at the valve.

"× 114 *Question.* Who would make it, knowing that essen-"tial fact?

"*Answer.* That would fall to the lot of the one designing the furnace."

Mr. Waite is thus candid enough to admit that in the nature of things the exact size cannot be set forth in a general specification. This disposes of his first "reason."

The remaining two have been already discussed at length in passing upon the similarity of the two patents, and the conclusion cannot be escaped that if the furnace of the British patent is inoperative, that of the American one is equally so.

But upon broader grounds this argument can be disposed of effectually.

In taking out their British patent the complainants professed to comply with the rigid conditions of the statute that they should set forth their invention so that any person skilled in the art could practice it.

Shall they now be heard to contradict this statement, and without a word of explanation as to the actual facts, be permitted to say that their former description was a fraud upon the public?

It is unnecessary to consider whether or not they are technically estopped; the point really is that nothing short of the most conclusive testimony on their part could overcome the weight of their previous emphatic assertion.

The entire sum of complainants' argument is that the *specific* forms and arrangements of several parts of the apparatus described in both of the patents (Reissue No. 3265 and English patent No. 167) and shown in the reissue, are varied from the *specific* forms shown as well as described in the English patent, and that the reissue claims *only*, and the English patent comprises *only*, the combinations of the specific forms and arrangements shown in them *respectively*: the claims of the reissue being so strictly limited that a furnace built according to the English patent 167, including the introduction of the air and gas side by side, would not include or contain the combination mentioned in the first claim of the reissue.

In the absence of any intimation in the specification of the reissue that one of the improvements claimed consisted in the introduction of the air in a way different from that described in the specification; or that the *shape* of the valves shown was one of the inventions claimed, or that the combinations specified were not combinations of the things described, but only of those things of the shape and under the particular arrangement *shown*, the theory upon which complainants' experts base their opinions and upon which they construe the claims of the reissue, is neither commendable to reason nor reconcilable with authority.

Clark *vs.* Adie, L. R., 2 Appeal Cases, 315.

SECOND POINT.

THE REISSUED PATENT SUED UPON, THE ORIGINAL OF WHICH WAS GRANTED MARCH 1ST, 1864, EXPIRED ON JULY 20TH, 1878.

Assuming that it has been established that Charles W. and Frederick Siemens, who took out the original patent of the reissue now sued on, had previously, on July 19th, 1861, taken out an English patent for substantially the same invention, this part of the argument of the appellees is to show that the duration of the American patent granted March 1st, 1864, cannot exceed seventeen years from the date of the prior English patent for the same invention, which was sealed July 19th, 1861.

The duration of the American patent sued on, which was originally granted in 1864, depends upon the construction placed upon the existing statutes on that subject in force at that time.

The statutes in force at that time were the act of July 4th, 1836 (5 U. S. Stat. at Large, 117); the act of March 3d, 1839 (5 U. S. Stat. at Large, 353); and the act of March 2d, 1861 (12 U. S. Stat. at Large, 246).*

The act of 1836, in its seventh section, authorized the commissioner of patents to issue a patent in the cases provided for in the sixth section of the act, if it should not appear to him, *inter alia*, that the invention or discovery "had been patented "or described in any printed publication in this or any foreign "country. * * *"

This broad language would have prevented the grant of an American patent to any one for an invention previously patented abroad.

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*The prior acts of April 10th, 1790 (1 U. S. Stat. at Large, 109); of February 21st, 1793 (1 *Id.*, 318); of April 17th, 1800, (2 *Id.*, 37); and of July 13th, 1832, (4 *Id.*, 577); under which aliens were entitled under certain circumstances to have patents granted to them had all been repealed by the twenty-first section of the act of July 4th, 1836 (5 U. S. Stat. at Large, 125).

Accordingly, in the next section, the eighth of the act, we find this proviso: "But nothing in this act contained shall "be construed to deprive an original and true inventor of "the right to a patent for his invention, by reason of his hav- "ing previously taken out letters patent therefor in a foreign "country, and the same having been published at any time "within six months next preceding the filing of his specification and "drawings."

The effect of this proviso was to give an inventor six months after the taking out of his foreign patent, in which to apply for a patent for the same invention in this country. The sixth section of the act of March 3d, 1839 (5 U. S. Statute at Large, 354), provided that "no person shall be debarred from "receiving a patent for any invention or discovery, as pro- "vided in the act approved on the fourth day of July, one "thousand eight hundred and thirty-six, to which this is ad- "ditional, by reason of the same having been patented in a "foreign country more than six months prior to his applica- "cation: *Provided*, That in all such cases every such patent "shall be limited to the term of fourteen years from the date "or publication of such foreign letters patent."

The effect of this statute was to allow an inventor to take out letters patent here at any time for an invention previously patented abroad, but the term of the American patent was limited to fourteen years from the date of the foreign patent.

The act of 1861, by its sixteenth section (12. U. S. Stat. at Large, 249), provided "That all patents hereafter granted shall "remain in force for the term of seventeen years from the date "of issue; and all extension of such patents is hereby pro- "hibited." And the next section of the act repealed all acts and parts of acts inconsistent with the provisions of the act of 1861.

Had the act of 1861 not been passed the patent of 1864 would have expired at the end of fourteen years from the date of the English patent, viz., at the end of fourteen years from July 19th, 1861.

It is submitted that the only effect of the act of 1861 was to make the American patent "remain in force" till the end of

seventeen instead of until the end of *fourteen* years from the date of the prior English patent, July 19th, 1861.

There is no expressed legislation in the act of 1861 on the subject of American patents for inventions patented abroad. The sixteenth section of that act deals generally with the length of the term of all patents, by making it seventeen years, and prohibits extensions of all future patents.

Prior to 1861 American patents for inventions previously patented abroad were limited to fourteen years from the date of the foreign patent.

There is nothing in the act of 1861 to evidence a purpose to change the policy of the act of 1839, which was to make an American patent for an invention previously patented abroad expire at the same time as if patented in this country at the time when first patented abroad. This policy said to the inventor: "If you choose to patent abroad, all right, "but you cannot afterwards obtain protection here any longer "than if you had patented in the first instance in this country." A mere change in the length of the term of American patents would not involve any alteration of this policy. Nor does the language of the act require any such construction.

The words are "all patents hereafter granted shall remain "in force for the term of seventeen years from the date of "issue."

The "date of *issue*" from which the seventeen years begins to run is not necessarily the "date of *issuing*," as is clearly shown by Mr. Justice Blatchford in De Florez *vs.* Raynolds (17 Blatchford, 445–6).

The whole subject is very thoroughly discussed by Mr. Justice Blatchford in De Florez *vs.* Raynolds, 17 Blatchford, 436, where all the cases before that time (February, 1880) are reviewed; and the judgment then reached has been followed by the third Circuit in the present case, and by Judge Wheeler in Nathan *vs.* N. Y. Elevated R. R. Co., 2 Fed. Rep., 225.

II.

THERE IS NO PROOF OF ANY INFRINGEMENT BY THE DEFENDANTS OF THE PATENT SUED ON.

The entire evidence in chief on the part of the complainants is a certified copy of the letters patent on which suit was brought. (See Record, page 8.) Having offered these letters patent in evidence, they rested, relying upon the answer of the defendants for proof of infringement. The answer of defendants is found on page 5 and 6 of the record. The fourth paragraph is as follows:—

"We deny that we have, or that either of us has, made, "used, or sold furnaces embracing in their construction or "mode of operation substantially the same invention patented "in said reissued letters patent."

If there were no more on this subject in the answer than is contained in the paragraph just quoted, clearly there would be no evidence of infringement in the case; but the next paragraph, the fifth paragraph of the answer, is as follows:—

"We believe that the Midvale Steel Works, a corporation "organized under the laws of the State of Pennsylvania, and "doing business in the city of Philadelphia, has, since July "22d, 1878, used a furnace embodying substantially the con- "struction and mode of operation specified and claimed in "said reissued letters patent; and we admit that we have "been directors of the said corporation since July 22d, 1878, "but we are informed and believe that such user by such cor- "poration of which we have been, as aforesaid, directors, "even if it constituted a violation by said corporation of the "rights of the complainant under said letters patent, is not a "violation of said rights for which we or either of us is in "any way liable or accountable."

The contention of the appellants is that the defendants, having been directors of the Midvale Steel Works while the company was using an infringing furnace, are responsible in damages for such use.

Ordinarily, a master is reponsible for the infringement of a patent by a servant working under his orders. Such infringement is "the natural consequence of something done by

"the servant with ordinary care in the execution of his mas-"ter's specific orders," and in such a case the master is responsible. Pollock on Torts, page 72.

While this is unquestionably the rule, yet the directors of a corporation, it is submitted, are not individually responsible for the infringement of a patent by the workmen of the corporation in the course of their regular duty.

The question is really one of agency. If the workmen are the servants of the directors, then, of course, the directors are responsible for their acts. If, on the other hand, the workmen are the servants of the corporation, then the corporation and not the directors of the corporation are responsible for their acts. The workmen cannot be the servants of both the corporation and the directors. They must be the servants of either one or the other, and cannot be of both. Laugher *vs.* Pointer, 5 Barnwell & Cresswell, page 559.

The rule in regard to the responsibility of an intermediate agent is thus stated by Judge Story in his work on Agency, section 313:—

"No action will ordinarily lie against an agent for the mis-"feasance or negligence of those whom he has retained for "the service of his principal, by his consent or authority, "any more than it will lie against a servant who hires labor "for his master at his request, for their acts; unless indeed "in either case the particular acts which occasioned the dam-"age are done by the orders or directions of such agent or "servant. The action under other circumstances must be "brought either against the principal or against the immediate "actors in the wrong."

And several cases are cited by him, the leading one being Stone *vs.* Cartwright, 6 Term Reports, 411.

Dicey in his "Parties to Actions," page 490, * page 460, thus states the rule:—

"An action for tort may be brought either against the prin-"cipal, or the immediate actor in the wrong, but cannot be "brought against an intermediate agent."

A very interesting discussion on the subject will be found in Mersey Docks Co. *vs.* Gibbs, Law Reports, 1 English and Irish Appeals, 93.

To the rule as stated by Mr. Dicey there are two well recognized exceptions:—

First.—If the intermediate agent authorizes and directs the wrong he becomes primarily liable. He is in reality a co-trespasser.

Second.—Where the intermediate agent is "an independent "contractor," he becomes liable himself, and the principal ceases to be liable.

See Dicey on Parties to Actions, page 468, * page 450; Pollock on Torts (Blackstone Edition), * page 69.

The rule under the second exception is thus stated by Willes, J., in Murray *vs.* Currie, Law Reports, 6 C. P., 24–27:

"In ascertaining who was liable for the act of a wrong-"doer you can look to the wrongdoer himself, or to the first "person in the ascending line who is the employer and has "control over the work. You cannot go farther back and "make the employer of that person liable."

The practical difficulty in the application of this rule has been to settle when a person has *control* of the work.

Coming now, in the light of these recognized principles, to the question of the responsibility of the directors of a corporation for the tort committed by the workmen in the employ of a company, we find it well settled by all the authorities that the directors of a coporation do not stand in a position of independent contractors, but are the mere agents of a corporation, and that the persons employed by them to do the work of the corporation are not their servants, but the servants of the coporation, and that, therefore, where they commit a tort, the only persons liable are the persons committing the tort and the person who stands in the relation of master to them, to wit, the corporation itself.

There are two important English cases where this subject has been considered very carefully.

The first is Weir *vs.* Barnett *et al.*, Law Reports, 3 ~~Equity~~ Exchequer Division, page 32. In this case the directors of a company employed their brokers to issue a prospectus. The prospectus, as issued by the brokers, contained false statements. It was held that the brokers were really the agents not of the

directors but of the company, the directors being intervening agents, and that the directors, even though they had received money obtained by the company through the fraudulent statements in the prospectus, which they had found to be fraudulent at the time they received such money, were not liable for the fraud.

See, particularly, the opinion of Chief Baron Kelly, on pages 40, 41. This case was affirmed on appeal in Weir *vs.* Bell, Law Reports, 3 Exchequer Divison, 238, when Chief Justice Cockburn (page 247), stated the law as follows:—

"I concur in the view that the defendants, in what they "did, were acting as the agents of the company, and not as "principals, and, therefore, that they would not be liable, gen- "erally speaking, for misrepresentations made without their "authority by persons employed by them on behalf of the "company, and who in such employment were acting not as "their agents but as the agents of the company."

The other case is Cargill *vs.* Bower, Law Reports, 10 Chancery Division, 502. See, particularly, the opinion of Fry, J., on pages 513–514.

In Arthur *vs.* Griswold, 55 New York, 400, the court say:—

"The mere fact of being a director and stockholder is not, "*per se*, sufficient to hold a party liable for the frauds and "misrepresentations of the active managers of a corporation. "Some knowledge of and participation in the act claimed to "be fraudulent must be brought home to the persons charged."

Hewitt *vs.* Smith *et al.*, 3 Allen, 420, was the case of a trespass by the servant, a depot master, of a railroad corporation. In the course of the opinion in that case the court say:—

"The further question arises as to the personal liability of "Mr. Swift, the president of the corporation. As to this, we "are of the opinion that if Mr. Swift was, in his capacity of "president, the mere conduit for communications between the "corporation and the agent in charge of the depot, transmit- "ting to the latter the orders of the corporation as to remov- "ing intruders from the depot, he would not be liable in this "case and ought not to be joined in the same. On the other

"hand, if it was a personal order emanating from Mr. Swift, "and under such order the injury was inflicted, he would be "personally liable."

Bates *vs.* Caton, 37 Michigan, 199, is an interesting application of the rule. This was an action of trespass brought by Caton, who was a landowner, against Bates, the managing agent and superintendent of a mining company. There was doubt as to the exact line dividing the land of the company from that of Caton. The workmen of the company, acting to a certan extent under Bates' orders, had trespassed upon Caton's land, and cut large quantities of timber therefrom. In delivering the opinion of the court the judge uses the following language:—

"The judge laid down three propositions for the guidance "of the jury, and, in view of the state of facts exhibited, the "effect of the first two of these propositions was to allow the "jury to find Bates guilty of trespass, if satisfied that the sur- "face captain and his workmen committed it, and that Bates, "in his character of managing agent of the company, was "director and controller of the business in which it was com- "mitted. This was error." (Numerous cases cited.) "His "being managing agent of the company, and the trespass upon "Caton's land being in a course of business under his author- "ity as agent, could not of themselves make the trespass so "committed his trespass. It could not be regarded as done "for him or in his interest. Neither could the surface captain "and the workmen, in committing the trespass, be considered "as standing in his shoes as representing him. It is not "enough in such a case that there exists the relation of supe- "rior and subordinate. There must be something more. The "relation must be such that the subordinate is the servant or "agent of the superior in the particular course of business or "sphere of action in which the wrong was done. Such was "not the case here. In short, the requisite conditions to au- "thorize the application of this doctrine of *respondiat superior* "against Bates were not present. To apply it against him "would imply that the company could not be held liable, a "position which cannot be admitted."

The same rule has been specifically applied in patent cases, as follows :—

United Nickel Company *vs.* Worthington, 13 Federal Reporter, 393. Here, Judge Lowell said :—

"It would be a great hardship if the directors of a railway "or manufacturing corporation were bound at their personal "peril to find out that every machine which the company "uses is free from all claim of monopoly. No case precisely "in point has been decided, but the practice certainly is, to ask "for damages, only against the corporation. I am of opinion "that the only persons who can be held for damages are those "who should have taken a license, and that they are those "who own or have some interest in the business of making, "using, or selling a thing which is an infringement, and that "an action of law cannot be maintained against the directors, "shareholders, or workmen of a corporation which uses a "patented improvement."

In other cases it has been held that the directors might be enjoined: Goodyear *vs.* Phelps, 3 Blatchford, 91; Poppenhauser *vs.* Falke, 4 Blatchford, 495. In both these cases nothing but a provisional injunction was asked for, and therefore they decided nothing as to the case in hand.

See also Iowa Barb Steel Wire Company *vs.* Southern Barb Wire Company, 30 Federal Reporter, 123, to the same effect.

The directors of a corporation being liable for a tort committed by the workmen of a corporation only when they have so directly ordered it that they become in effect joint tort feasors, is the admission in the fifth paragraph of the answer on page 6 of the record sufficient to establish such a status against the defendants in the present suit? The admission is that "we believe that the Midvale Steel Works has, since July "22d, 1878, used a furnace embodying the construction and "mode of operation specified and claimed in said reissued "letters patent, and we admit that we have been directors of "the said corporation since July 22d, 1878."

There is nothing in that admission to show that they knew, at the time when the Midvale Steel Works used the furnace, of the fact of such user. They admit it now; but they do

not admit that they knew it at the time. There is nothing in their admission to show that they ordered, or in any way had the control of, the use of such furnace, nor is there anything in that admission to show that if some of them did order the use of such furnace that all of them did so; and there is nothing to show which one of them did so, if any. It is simply an admission that they were the directors of the corporation, and that the corporation was using such a furnace without any other fact connected with the subject, and the essential fact which must be connected with the subject before they can be made liable is that they controlled and ordered this use, and that cannot be inferred from the admission.

S. S. HOLLINGSWORTH,
JOSEPH C. FRALEY,
For Appellees.

123-286

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Supreme Court U. S.
FILED
OCT 14 1887
JAMES H. McKENNEY,
CLERK.

Supreme Court of the United States.

G. W. WILKINSON, *et al.*
Treasurer of Dakota County,
Plaintiffs in Error,

vs.

THE STATE OF NEBRASKA,
Ex Rel.,
The Society for Savings of the City of Cleveland

MOTION TO DISMISS AND AFFIRM, AND BRIEF OF DEFENDANT IN ERROR IN SUPPORT THEREOF.

J. M. WOOLWORTH,
ATTORNEY FOR DEFENDANT IN ERROR.

F. A. Manger, Printer, 1402 Farnam St. Omaha.

In the Supreme Court of the United States.

G. W. WILKINSON, *et. al.*,
Treasurer of Dakota County,
Plaintiffs in Error,

vs.

THE STATE OF NEBRASKA,
Ex. Rel.,
The Society for Savings of the City of Cleveland.

NOTICE OF MOTION TO DISMISS THE WRIT OF ERROR AND TO AFFIRM THE JUDGMENT.

Gentlemen:—

Take notice that on the ~~17th~~ 31st day of October, next, at the opening of court on that day, or as soon thereafter as counsel can be heard, I shall submit to the Supreme Court of the United States the motion hereto annexed to dismiss the writ of error in this cause and to affirm the judgment of the Circuit Court. Yours., etc.

J. M. WOOLWORTH,
Attorney for Defendant in Error.

To A. J. POPPLETON, Esq., and
J. M. THURSTON, Esq.,
Attorneys for Plaintiffs in Error.

Dated OMAHA, September 8th, 1887.

In the Supreme Court of the United States.

G. W. WILKINSON, *et. al.*,
Treasurer of Dakota County,
Plaintiffs in Error,

vs.

THE STATE OF NEBRASKA,
Ex. Rel.,
The Society for Savings of the City of Cleveland.

MOTION.

Now comes the defendant in error, by J. M. Woolworth, its attorney, and moves the court to dismiss the writ of error upon which the above entitled cause is removed into this court, on the ground that there was no jurisdiction to issue the same, nor is there any jurisdiction to take cognizance of the record filed herein. But should this court be of opinion that it has jurisdiction to issue and entertain said writ, the said defendant moves that the order and judgment of the Circuit Court, in the record set forth, be affirmed, on the ground that it is manifest that the same was taken for delay only, and that the question upon which the jurisdiction of this court depends is so frivolous as not to need further argument.

J. M. WOOLWORTH,
Attorney for Defendant in Error.

In the Supreme Court of the United States.

G. W. WILKINSON, *et. al.*,
Treasurer of Dakota County,
Plaintiffs in Error.

vs.

THE STATE OF NEBRASKA,
Ex. Rel.,
The Society for Savings of the City of Cleveland.

BRIEF ON MOTION TO DISMISS AND AFFIRM.

This is a writ of error to the Circuit Court of the United States, for the District of Nebraska, issued for the purpose of bringing here an order remanding the cause to the Supreme Court of the State of Nebraska. The original proceeding was an application to the Supreme Court of the state for mandamus to compel the plaintiff in error, Wilkinson, to apply monies in his hands, collected for the purpose, to the payment of past due coupons detached from bonds issued by the county.

The petition filed on the 14th of February, 1887, states that the relator was a corporation organized under the laws of the state of Ohio, and that the county of Dakota was a municipal corporation organized under the laws of the state of Nebraska,

and Wilkinson was its treasurer; and that the treasurer has collected and has in his hands twenty thousand dollars, properly applicable to the payment of past due coupons, representing the interest due upon bonds of the defendant county which belong to the relator, and prays a mandamus commanding him to apply the said monies to that purpose.

On the 1st of March, 1887, the respondents answered, admitting the substantial allegations of the petition, but denying the validity of the bonds, because they were issued in excess of the amount for which the county could issue such bonds. At the same time the respondents also filed their petition in the Supreme Court of the state for the removal of the proceeding into the Circuit Court of the United States, for the district of Nebraska, on the ground that the relator was a citizen of Ohio, while they were citizens of Nebraska.

On the 6th of April, 1887, the court directed the removal of the proceeding.

On the 19th of the same month a transcript of the record was filed in the Circuit Court; and on the 27th of May a motion to remand the proceeding was filed, on the ground that the Circuit Court was without jurisdiction to receive the said cause and hear and determine the same. This motion was sustained, and this writ is sued out to reverse that order.

FIRST POINT.

Until the passage of the Act of March 3d, 1887, this court had jurisdiction of a writ of error to a Circuit Court which remanded a cause to the State Court from which it had been removed. The last clause of section five of the Act of March 3d, 1875, (18 Stat. 472) gave this jurisdiction. The provision is as follows:

"But the order of said Circuit Court, dismissing or remanding said cause to a State Court, shall be reviewable by the Supreme Court on writ of error or appeal, as the case may be."

But this provision was repealed by the last clause of section two of the Act of 1887. That provision is as follows:

"Whenever any cause shall be removed from any State Court into any Circuit Court of the United States, and the Circuit Court shall decide that the cause was improperly removed, and order the same to be remanded to the State Court from whence it came, such remand shall immediately be carried into execution, and no appeal or writ of error from the decision of the Circuit Court so remanding such cause shall be allowed."

This clause divests this court of the jurisdiction conferred upon it by the Act of 1875.

The principle is elementary, and has been declared by this court a great many times, that all cases fall with the repeal of a statute conferring jurisdiction over them.

It is shortly stated by the Chief Justice in *South Carolina vs. Gaillard,* 101 U. S., 433, 438. "It is well settled that if a statute giving a special remedy is repealed without a saving clause in favor of pending suits, all suits must stop where the repeal finds them. If final relief has not been granted before the repeal went into effect, it can not be after."

The *Railroad Company vs. Grant,* 98 U. S., 398, was a motion to dismiss a writ of error to the Supreme Court of the District of Columbia, which brought here a judgment for $2,250. When the writ was sued out, this court had jurisdiction over judgments for $1,000 and more. Pending the writ here the jurisdictional amount was raised to $2,500. The Chief Justice says: "The Act of 1879 is undoubtedly prospective in its operation. It does not vacate or annul what has been done under the old law. It destroys no vested rights. It does not set aside any judgment already rendered by this court under the jurisdiction conferred by the Revised Statutes when in force. But a party to a

suit has no vested right to an appeal or writ of error from one court to another. Such a privilege once granted may be taken away, and if taken away, pending proceedings in the appellate court stop just where the rescinding act finds them, unless special provision is made to the contrary."

The last clause of section two of the Act of 1887, expressly provides for all cases remanded to the State Courts: it provides that the remand shall be immediately carried into execution, and that the order shall not be reviewed here. It is not possible to conceive of any terms of a statute more express, particular and decisive. If that were all of the new statute the case would be clear.

But besides this clause, taking from this court its jurisdiction to review orders remanding cases to the State Court, we have section six. That section, in terms, repeals the provision of the act of 1875, which had conferred that jurisdiction. But to the repealing clause is added a proviso, that the Act of 1887 "shall not affect jurisdiction over or disposition of any suit removed" before its passage. This proviso, however, is subject to an exception: it does not operate upon other express provisions of the act. As the last clause of section two is express, its operation is not qualified by the

terms of the proviso, and the repeal is effective as regards this case as well as any removed after the passage of the repealing statute.

There is another view to be taken of the terms of this proviso. It does not apply to cases like this, where all that had been done in the State Court was the filing the petition and bond for removal. No order had been passed by the State Court, either upon the petition for the removal or upon the bond and the sufficiency of the sureties, nor had a transcript been taken out or filed in the Circuit Court, when the Act of 1887 was approved. Within the meaning of the proviso, the cause had not been removed at that time. We are not unmindful of expressions in the opinions of the judges of this court, that the single act of filing the petition and bond without more effected the removal. But those expressions are to be referred to the circumstances of the cases in which they were made.

They were of two classes, in one of which the State Court refused the removal and proceeded with the cause, and it was brought here by writ of error to the Supreme Court of the state.

Gordon vs. Longset, 16 Pet. 97.
Kanouse vs. Martin, 15 How. 198.
Insurance Company vs. Dunn, 19 Wall. 244.
Virginia vs. Reese, 100 U. S. 313.
Railroad Company vs. Mississippi, 102 U. S. 135.
Railroad Company vs. Koontze, 104 Ib. 5.
Steamship Company vs. Tugman, 106 Ib. 118.

In the other class of cases, the transcript having been filed in the Circuit Court, the question was whether the cause was of a nature to be removed. This class is so numerous and familiar that we can not name them.

In neither of these classes of cases was it material to consider the point of time when the rights of the parties became fixed. Thus in the first class whether the removal was definitively effective when the petition and bond were filed or when the State Court refused to remove the cause, did not matter: the complaint was that it proceeded to hear and determine the case. And in the second class the question was, whether the cause was removable, not what the rights of the parties were at the date of its removal.

And we know that practically a case is not removed until something more is done than filing the petition and bond. If a party were to file

those papers but never bring them to the attention of his adversary or the judge, nor file the transcript in the Circuit Court, and were to go to trial in the State Court and suffer defeat, he could not attack the judgment collaterally as rendered without jurisdiction.

And other cases may be supposed to show that something more than merely filing the bond and petition must be done to operate the removal of the cause. Certainly, in common parlance, a cause is not said to be removed until the record is filed in the Circuit Court. Even most lawyers, and certainly laymen, would not speak of a cause as removed when the proceeding is initiated: they think of the process as consumated only when the Circuit Court, having possession of the record, is ready to exercise its powers over it and over the parties.

The word "removed," in the proviso to section six of the Act of 1887, was understood by its framers as describing a suit in which not only had a petition and bond been filed in the State Court, but the transcript had been filed in the Circuit Court. To the word ought not to be attributed all the meaning with which the judges of this court might use it. The whole Acts shows that

its framers did not know the exact meaning of legal terms and were not able to speak or write our language accurately. The term ought to be taken in its popular and not in its technical sense.

But at the time the petition and bond for the removal of this case was filed in the Supreme Court of the state the proceedings had not reached such a point that the case could then be removed. All that had been done was the filing of a petition for the writ, to which the defendants, after notice, had filed an answer. This was merely preliminary to the institution of the suit, if such it may be called. The real controversy could not be presented to the court and the rights of the parties definitely considered and determined upon these papers. They were merely preliminary and called upon the judges to say whether the case made justified them in awarding an alternative writ. This is clear from an examination of the statute of the state regulating proceedings upon mandamus. They are set forth in chapter three of Title XVIII, of the Code of Civil Procedure, at page 616, of the Compiled Statutes. A copy of this statute is annexed to this brief. In section 653 it is provided, that "no other pleading or written allegation is allowed than the writ and answer. These are the pleadings in the

case, and have the same effect and are to be construed and may be amended in the same manner as pleadings in a civil action."

Until, upon the petition and answer filed in the Supreme Court of the state, the judges thought there was a *prima facie* case for the writ, and issued it, no action was pending which could be removed to the Circuit Court. Had the motion to remand not been filed, and the judges of the Circuit Court been of opinion that a *prima facie* case was made for the writ, the proceeding would have been an original one in that court, and therefore not within its jurisdiction.

It is fair to say that the Supreme Court of the state has made a rule on the subject supplementing the statute on mandamus, which is as follows: "In all cases of application to this court for a writ of mandamus, a reasonable notice must be given to the respondent of the time when it will be made, accompanied by a copy of the affidavit on which it is based, unless for special reasons it is otherwise ordered; and except in urgent cases, the time of the hearing shall be during the week to which the causes from the district in which the respondent resides are assigned."

This rule does not attempt to supersede or repeal section 653 of the Code, above referred to; it only provides for a notice of the application for the alternative writ, upon which the preliminary question is considered, whether the writ shall go; and also for a hearing upon the writ after it has been awarded. We can not suppose that the judges of the Supreme Court of the State contemplated any change in the statutory proceedings. Had the respondents been patient and waited for the writ to go, and when making their return thereto, had seen fit to file their petition and bond for removal, the proceedings would have been in a condition of advancement, when such a step would have been proper. But they anticipated that act, and the whole proceedings for the removal of the case were void.

SECOND POINT.

The order remanding the cause was right, and does not deserve further discussion, after the decision of this court in *Rosenbaum vs. Bauer,* 120 U. S. 450. That case is the more interesting, because instituted under a statute of the state of California, which dispensed with the use of the name of the state as a party to the record, and provided that the

party usually known as the relator, for the vindication of whose rights the writ issued, should file a petition as a plaintiff in an ordinary civil action. Statutes of the same character have also been passed in England and in Iowa, and many other of the states. The legislature of Nebraska has not gone so far.

On the other hand proceedings in mandamus in the State of Nebraska retain their prerogative character. This will appear from an examination of the statute. The Code of Civil Procedure, (Compiled Statutes, 531) like all practice acts of that character, abolishes the distinction between actions at law and suits in equity, and provides in section two that "in their place there shall be one form of action, which shall be called a civil action;" and in section three, that "in such action the party complaining shall be known as the plaintiff, and the adverse party as the defendant;" and in section twenty-nine, that "every action must be prosecuted in the name of the real party in interest," excepting certain cases within which a mandamus proceeding does not come.

By section sixty-two (page 538) it is provided that "a civil action must be commenced by filing in the office of the clerk of the proper court a

petition, and causing a summons to be issued thereon. Section sixty-four provides for the form of the writ of summons. Section ninety-two provides that "the petition must contain — First, The name of the court and county in which the action is brought, and the names of the parties, plaintiff and defendant. Second, A statement of the facts constituting a cause of action, in ordinary and concise language and without repetition. Third, A demand of the relief to which the party supposes himself entitled. If the recovery of money be demanded, the amount thereof shall be stated; and if interest thereon be claimed, the time from which interest is to be computed shall also be stated.

Following this section are several others, laying down rules of pleading, and specifying the particular days upon which pleadings shall be filed.

The whole course of procedure in an ordinary action, as well equitable as legal in its character, is laid down with particularity. In England, and in Iowa, California and several of the other states, the proceedings in mandamus are the same as those in an ordinary action, except simply in the prayer for relief.

Such being the character of a civil action in Nebraska, we have now to inquire what the provis-

ions of the Code are with reference to mandamus.

Title XVIII, (page 614) of the Code, is entitled "Actions and Proceedings in particular Cases." This language clearly indicates a purpose to distinguish "actions" from a special class of "proceedings." Chapter one of this Title is entitled "Actions concerning Real Property," and in it such special provisions as the nature of that class of cases requires, are set forth. Chapter two is entitled "Actions on Official Securities," and in this chapter we have again the special provisions necessary in such actions. Then comes chapter three, which is entitled "Proceedings upon Mandamus." The language here changes; instead of "actions" we have "proceedings." A copy of this chapter is annexed to this brief.

Thus we see that the legislature of Nebraska has been careful to maintain the distinction between an ordinary civil action and Mandamus. In this chapter no distinction is made between such prerogative writs as at the common law could only issue in behalf of the Crown, and such as issued for the relief of the citizen. But it is provided, in section 646, that the writ may issue on the information of the party beneficially interested. The proceedings described in this chapter do not materially differ

from the common law practice. It has always been the usage in Nebraska, under this chapter, to issue the writ in the name of the State, just as in England it used to issue in the name of the king; and, furthermore, when a citizen is beneficially interested he is named, not the plaintiff, but the relator. The return day of the writ does not follow the rule in an ordinary action, but such day as the court appoints. The pleadings and allegations are set forth in the writ and the answer thereto, instead of in a petition and answer. Other provisions of the chapter suggest material differences between proceedings upon mandamus and in an ordinary action.

This legislation shows a well considered purpose on the part of the legislature to retain the distinctive nature of proceedings in this class of cases, as they existed at the common law.

This case, therefore, stands upon much stronger grounds than the California case, cited above; and whatever difficulties the judges found in dealing with that case, do not present themselves here.

It is just, therefore, to say that the proceeding is not such a common law action as the several acts of Congress conferring jurisdiction upon the federal courts describe.

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But there is a more radical difficulty in this case. The claim to the removal from the state to the federal court rests only upon the citizenship of the parties. To be sure, the relator is a citizen of Ohio, and the respondents are citizens of Nebraska; but the real party is the State, which can not be a litigant in the federal courts, except in a very limited class of cases, to which this does not belong. It can not sue in the federal courts, nor can it be sued there. If it bring an action in its own courts, the controversy can not be wrested from their jurisdiction, and determined in the tribunals of another sovereignty. Not only is the State the real party in this proceeding because in early days mandamus was a prerogative writ and the traditional procedure has been continued, notwithstanding a modification of its character, but because the performance of the duty enjoined in the process is in behalf of the State. In this particular case, the county treasurer, as an officer of the State, has collected from its citizens a certain sum of money for the express purpose of applying it to the payment of a debt. There is nothing which more deeply concerns the sovereignty than the exact and prompt performance of the official duties of its agents. To be sure, the relator is more particularly

interested in the performance of this official duty, but so also is the public. This is just as much so in this case as in the case of a nuisance. The party specially injured thereby may complain, and pray its abatement; but so also may the State. As the the guardian of the common interests of all its citizens, it is the duty of the sovereign to suppress the nuisance. Just so here; the orderly administration of public affairs involves the highest interests of all, and the duty rests upon the State to be diligent in securing the same.

Thus we see that, first, in matter of form, and, secondly, in matter of substance, the State is the necessary party in whose behalf the writ issues and is enforced.

It is said that this proceeding is for the collection of a debt, and therefore is an action within the description of the Acts of Congress. Let us see if that makes any difference. If there were no ground alleged by the treasurer for his refusal to apply the money in his hands to the payment of these coupons, there can be no doubt that the State, by its attorney general, without the information of a relator, might have the writ of mandamus to compel the payment: and it could not be said in such a case that the State was not the real

party in interest in the proceeding. The case, so far as its jurisdiction is concerned, is not changed by the fact that the respondents allege a defense. The nature of the case and the jurisdiction over it must be determined by the writ itself, and not by the nature of the dispute which the defendants raise by their return thereto. And if such a case may be prosecuted by the State without a relator, for the purpose of compelling the performance of an official duty by its agent, then the use of the name of a relator does not modify the nature of the proceeding.

These considerations, briefly stated, are pertinent here, after the decision in the case cited above of *Rosenbaum vs. Bauer*, only for the purpose of showing that this case is much stronger than that. In California, the proceeding is prosecuted without the use of the name of the State, by the relator as plaintiff in an ordinary civil action. In Nebraska it must be prosecuted by the State, which is deeply concerned in the performance of the duty enjoined. The contention that this is a proceeding to collect a debt is met by the case cited, which was equally of that character.

J. M. WOOLWORTH,

Attorney for Defendant in Error.

COMPILED STATUTES PAGE 614.

TITLE XVIII. — ACTIONS AND PROCEEDINGS IN PARTICULAR CASES.

CHAPTER I. — ACTIONS CONCERNING REAL PROPERTY.

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CHAPTER II. — ACTIONS ON OFFICIAL SECURITIES.

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CHAPTER III. — PROCEEDINGS UPON MANDAMAS.

SEC. 645. (OFFICE OF WRIT.) — The writ of mandamus may be issued to any inferior tribunal, corporation, board, or person, to compel the performance of an act which the law specially enjoins as a duty resulting from an office, trust or station. But though it may require an inferior tribunal to exercise its judgment, or proceed to the discharge of any of its functions, it can not control judicial discretion.

SEC. 646. (WHEN NOT ISSUABLE — PARTY INTERESTED.) — This writ may not be issued in any case where there is a plan and adequate remedy in

the ordinary course of the law. It may issue on the information of the party beneficially interested.

SEC. 647. (COMMANDS OF WRITS.)—The writ is either alternative or peremptory. The alternative writ must state concisely the facts showing the obligation of the defendant to perform the act, and his omission to perform it, and command him that, immediately upon the receipt of the writ, or at some other specified time, he do the act required to be performed, or show cause before the court whence the writ issued, at a specified time and place, why he has not done so; and that he then and there return the writ, with his certificate of having done as he is commanded. The peremptory writ must be in a similar form, except that the words requiring the defendant to show cause why he has not done as commanded, must be omitted.

SEC. 648. (WHICH WRIT ISSUED.)—When the right to require the performance of the act is clear, and it is apparent that no valid excuse can be given for not performing it, a peremptory mandamus may be allowed in the first instance. In all other cases, the alternative writ must first be issued.

SEC. 649. (MOTION FOR WRIT—NOTICE.)—The motion for the writ must be made upon

affidavit, and the court may require a notice of the application to be given to the adverse party, or may grant an order to show cause why it should not be allowed, or may grant the writ without notice.

SEC. 650. (ALLOWANCE—SERVICE—CONTEMPT.)—The allowance of the writ must be endorsed thereon, signed by a judge of the court granting it, and the writ must be served personally upon the defendant. If the defendant duly served neglect to return the same, he shall be proceeded against, as for contempt.

SEC. 651. (ANSWER)—On the return of day the alternative writ, or such further day as the court may allow, the party on whom the writ shall have been served, may show cause, by answer made, in the same manner as an answer to a petition in a civil action.

SEC. 652. (SAME—DEFAULT—NEW MATTER)—If no answer be made, a peremptory mandamus must be allowed against the defendant. If an answer be made containing new matter, the same shall not in any respect conclude the plaintiff, who may, on the trial or other proceeding, avail himself of any valid objection to its

sufficiency, or may countervail it by proof, either in direct denial or by way of avoidance.

SEC. 653. (PLEADINGS)—No other pleading or written allegation is allowed, than the writ and answer. These are pleadings in the case, and have the same effect and are to be construed and may be amended in the same manner as pleadings in a civil action; and the issues thereby joined must be tried, and the further proceedings thereon had in the same manner as in a civil action.

SEC. 654. (DAMAGES)—If judgment be given for the plaintiff, he shall recover the damages which he shall have sustained, to be ascertained by the court or a jury, or by referees, in a civil action, and costs; and a peremptory mandamus shall also be granted to him without delay.

SEC. 655. (SAME—BAR TO OTHER ACTION)—A recovery of damages by virtue of this chapter, against a party, who shall have made a return to a writ of mandamus, is a bar to any other action against the same party for the making of such return.

SEC. 656. (DISOBEDIENCE—CONTEMPT—FINE)—Whenever a peremptory mandamus is directed to any public officer, body, or board, commanding the

performance of any public duty, specially enjoined by law, if it appear to the court that such officer, or any member of such body or board, has, without just excuse, refused or neglected to perform the duty so enjoined, the court may impose a fine not exceeding five hundred dollars, upon every such officer, or member of such body or board. Such fine, when collected, shall be paid into the treasury of the county where the duty ought to have been performed; and the payment thereof is a bar to an action for any penalty incurred by such officer, or member of such body or board, by reason of his refusal or neglect to perform the duty so enjoined.

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IN THE

SUPREME COURT

OF THE UNITED STATES.

G. W. WILKINSON, ET AL., TREASURER, DAKOTA COUNTY,
Plaintiffs in Error.

vs.

STATE OF NEBRASKA EX. REL. THE SOCIETY FOR SAVINGS OF THE CITY OF CLEVELAND.

Motion to Dismiss and Affirm.

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The questions which must determine this motion are these:

1. Does the removal act of March 3, 1887, cut off the remedy, by writ of error to the Supreme Court, previously existing under former removal acts, in all cases arising under the act of 1887, and render the judgment of the Circuit Court remanding this cause, final?

2. Is the case at bar, being in form, mandamus, removable under the removal act of March 3, 1875?

FIRST.

The claim is made that the last clause of section 2 of the act of

March 3, 1887, absolutely prohibits an appeal or writ of error from the decision of the Circuit Court to the Supreme Court of the United States in any case in which the Circuit Court shall remand the cause as not removable. If this be a sound construction of the law it results that the great mass of cases of which the federal courts are given jurisdiction by removal from the state courts, are cut off from remedy by appeal or writ of error to the Supreme Court of the United States, in any case in which the Circuit Court shall deny the jurisdiction. It is believed that the policy of this act was rather to restrict removals in cases of minor amount and confine it to non-resident defendants than to deprive the suitor of the final judgment of the Supreme Court of the United States upon the validity of the removal by direct proceedings from the Circuit Court.

It can hardly have been the intention of congress to compel a party in every instance to litigate his case through the state court and thus reach the supreme court.

The litigation pending in the circuit court of the United States by removal is probably not less in importance or in magnitude of interests involved than that acquired by original jurisdiction. It is difficult therefore to say upon what policy congress could have proceeded to make the judgment of the circuit court of the United States final in one class of cases while leaving the remedy open in cases of not greater magnitude or importance to the Supreme Court of the United States. It seems to us that the act is susceptible of a different construction; indeed that in view of all the circumstances it requires a different construction.

Section 2 provides for the removal of three classes of cases: Suits of a civil nature at law or in equity, of which the circuit court would have had original jurisdiction, arising under the

constitution or laws of the United States; like suits pending between citizens of different states, wherein the defendant or defendants are non-residents of the state and the removal is sought by them.

The method of proceedure to effect removal in this class of cases is pointed out in section 3 of the act and does not differ, except in minor particulars, from previous proceedure; but section 2 also deals with another class of removals, namely, those in which the citizenship is in different states and in which the defendent or defendants being a citizen of a state other than that in which the suit is brought, shall make it appear to the Circuit Court to which the removal is sought, that from prejudice or local influence he will not be able to obtain justice in said state or in any other state court to which the defendant might, according to the laws of the state, on account of such local prejudice or influence, remove said cause. This portion of the statute evidently contemplates that the application for removal shall be made to the Circuit Court. It is not the intention of the statute that the application for removal shall be made, as before its passage to the state court, and that the validity of the application shall rest upon the simple declaration of the applicant that he cannot obtain justice by reason of prejudice or local influence, in the state court; but that the applicant should go at once to the circuit court of the United States, with further provisions of law empowering and requiring the Circuit Court to examine in detail into the grounds upon which such application has been made, and unless it shall appear to the satisfaction of the circuit court that the applicant cannot obtain justice in the state court, the cause must be remanded. This is a radical revolution in the law of removal in this class of cases. Its purpose is to permit and require the circuit court of the United States, upon such an application, to hear and determine, with

the aid of witnesses and every other means of advising the court, whether it is a removal case.

It is to be noted that the removability of a case of this sort does not depend upon matter of law. It depends wholly upon the showing of the facts, which may be made by oral or written testimony, and which (if either party so elect) may develop into substantially a trial of fact. The question to be settled therefore, is one which the Supreme Court of the United States, if it were disposed, is not well adapted to solve, for the reason that an appelate court, not having before it the witnesses in persons upon whose testimony the matter must be determined, is illy adapted to settle such questions; besides it is contrary to the practice of the court to embark in that sort of enquiry in law cases; its function being the determination of questions of law rather than fact. There could be no appeal from an order remanding a cause removable for local prejudice that would not involve exclusively a determination of matters of fact. The circuit judge having before him, in the locality in which the transaction arises, the proofs and witnesses, his judgment may well be made final.

It is submitted therefore, that the following from section 2: "whenever any cause shall be removed from any state court into any Circuit Court of the United States, and the Circuit Court shall decide that the cause was improperly removed and order the same to be remanded to the state court from whence it came, such remand shall be immediately carried into execution and no appeal or writ of error from the Circuit Court, so remanding such case, shall be allowed," does not apply to the case at bar. While this seems to be an independent and sweeping provision and upon the full breadth of its language might be applied to every removal case provided for

in the act; in view of the fact that it stands as a quotation from a former law side by side with a quotation from a former law immediately preceding it, which cannot by any possibility apply to anything except a case of removal grounded upon local prejudice; considering the policy and reason of the statute, the construction, as we think, may fairly be adopted; applying it only to cases of removal for prejudice or local influence. These considerations show that it could not have been the intention of Congress to deny the writ of error in any case of removal under the act of 1887, in which the cause is remanded by the Circuit Court, but that the clause relied upon as accomplishing that purpose has sole reference to removals for prejudice and local influence. If this view of the statute is correct, section 6 saves and preserves the right to remove in any suit removed from the court of any state, before the passage of the act of March 3, 1887.

This case cannot, under the language of section six, be taken out of the category of removable cases, except upon the construction that the last clause of section two "otherwise expressly provides" in a case removed before the passage of the act. If the last clause of section two is an absolute prohibition against a writ of error in all cases remanded, then the act itself expressly prohibits the writ as well in cases removed previous to the passage of the act, as subsequent to it; but if on the other hand, the last clause of section two applies only to prejudice and local influence cases, then the exception of section six operates in favor of the case in bar, provided it was removed before March 3, 1887.

Reference to the record will show that the suit in controversy was brought by petition in the Supreme Court of Nebraska in February, 1887, a notice being given that on the 15th day of

February the Relator would apply for a writ of mandamus as prayed in his petition. Reference to the prayer of the petition shows that the Relator prays "that a writ of mandamus directed to the said respondents may issue out of this court declaring the said bonds and coupons to be a legal and valid obligation of said County and ought to be paid as the same come due, commanding said Treasurer to pay to your Relator for and on account of said past due and upaid coupons what shall be found due thereon, within a short day, to be limited by this court." To this petition the respondents, on the 1st of March, filed their answer. Also petition and bond for removal.

The State of Nebraska in respect to mandamus provides that the proceedings shall be inaugurated by a motion made to the court for the writ, and that said motion shall be made upon affidavit, and that the writ may be allowed upon hearing or may be granted without notice. Section 649, Statute.

This practice led to a double hearing, or at least an attempt to get a double hearing in almost every mandamus case, namely, upon the application and by way of answer to the alternative writ, in case the same was issued. If, however, the court granted the peremptory writ in the first instance, as it might do, then the respondent was practically deprived of the power to defend, except as he made his defense upon the application for the writ.

The rule adopted by the court and quoted on page 12, of Relator's brief, shows that the intention of the court was in all cases to give the defendant an opportunity to answer and be heard fully upon the preliminary application. Accordingly the practice has sprung up of embodying in the petition for the writ everything that in ordinary practice in mandamus

cases would be incorporated into the alternative writ. An examination of the petition in this case will show that it contains all the essentials of the alternative writ. Neither the statute nor the rule of the court recognizes any such paper as a petition in a mandamus case. The requirement of both is that the application should be made upon motion supported by affidavit. The petition in this case therefore being in form and substance identical with, can only be regarded as in substance the alternative writ. The respondents knowing that the whole question must be practically settled and determined upon the hearing upon this petition answered the same fully, and its answer contains everything necessary to constitute an answer to the alternative writ. So we say, that looking beyond the form to the substance of things, the whole controversy in this case is embodied in the petition and the answer filed. If this view of the situation of the suit is correct, then the application for removal was filed, and the removal took place, prior to the passage of the removal act of March 3, 1887. On the filing of a proper petition and bond in a suit which is removable, a state court is divested of jurisdiction and the cause is removed.

Kern vs. Heidkofer, 103 U. S. 485.
Railroad Company vs. Koontz, 104 U. S., page 5.
Steamship Company vs. Tugman, 106 U. S. 118.

SECOND.

Is the case at bar, being in form mandamus, a suit of a civil nature at law or in equity which is removable under the act of March 3, 1875? Here we are met by the case of Rosenbaum vs. Bauer, 120 U. S. 450, which is produced as settling this question. It is not the intention to call in question or enter into an argument in respect to the precise matters decided in

that case. Nothing could be added to the force or completeness of the argument of the dissenting opinion, but it is respectfully submitted that the two cases are not identical.

If there is one principle, which has entered into the adjudications of the Supreme Court of the United States, more beneficial and just in its effect than another, it is this: that the court will look through the forms and words in which a transaction is clothed, to the substance of things, and deal with it accordingly. So it has been held in matters of interstate commerce; no matter what the language used might be, if an examination of the case at bar disclosed the facts necessary to place the case on one side or the other of the dividing line of jurisdiction between the federal and the state courts, this court would exercise its jurisdiction accordingly; and that no form of evasion, no doubtful or uncertain language or form of proceeding would be allowed to withdraw the essential question involved from the jurisdiction of the court. So in respect to parties in removable cases; it has been repeatedly held that where the controversy was wholly between the citizens of one state and the citizens of another state, without reference to whether they were plaintiffs or defendants, the jurisdiction of the court attached. In other words, the court would range the parties upon opposite sides of the controversy, according to their interest, and not as designated plaintiffs or defendants, and if it then appeared that there was a controversy wholly between the citizens of one state and the citizens of another, the jurisdiction for removal attached. So, applying the same principle in this case, if it can be seen that this controversy, although nominally a mandamus proceeding, is nothing more than an ordinary civil action for the recovery of a judgment and the collection of a debt, the court should disregard the form which the controversy has assumed and deal with it in its actual character.

The Society for Savings of the City of Cleveland is a corporation whose business it is to loan money and invest its resources for an interest income. In the exercise of its functions in that character it has invested a portion of its means in certain bonds of the County of Dakota and State of Nebraska. Interest coupons upon these bonds are in default. Being a corporation of the State of Ohio, and the County of Dakota and its treasurer being citizens of the State of Nebraska, there was no obstacle to bringing the case within the jurisdiction of the federal court and instituting suit in the first instance in the Circuit Court of the United States. In that case, of course the removal of the adjudication of the Circuit Court to this court by writ of error would have been inevitable. In lieu of this, taking advantage of the statute of the State of Nebraska, which allows a private person to resort to the writ of mandamus in the name of the state, in a proper case, this suit is instituted in the name of the State of Nebraska upon the relation of this corporation, for the simple and only purpose of collecting the debt set forth in the petition.

The petition contains precisely the allegations that would be necessary in an original suit to recover a judgment for the amount of the interest coupons in default. The prayer of the petition is that a mandamus directed to the respondents may issue out of the court "declaring the said bonds and coupons to be a legal and valid obligation of the said county." This is in effect simply a prayer for a judgment, and no mandamus could rightfully issue to compel the treasurer to pay the coupons out of the moneys in his hands collected for that purpose, or otherwise, until there was first a finding that these bonds were a valid and legal obligation against the county. I think it may be safely said that the books will be searched in vain for a case in which a mandamus has been allowed in an ordinary action of debt,

making a finding of a judgment for the amount due upon the debt. It is, as it seems to me, impossible to distinguish this case—putting in issue the validity of these bonds and coupons, which has never been passed upon or adjudicated—from an ordinary action of debt.

It seems rather an effort to evade that very issue by putting the proceeding in a form in which it cannot be reached before the only tribunal which ought to settle it, as between the citizens of different states. This court does not need to be informed that upon the question of validity of municipal bonds there are, in some instances, radical differences between it and the highest courts of the states. Assuming that the Supreme Court of the State of Nebraska has passed upon the validity of similar bonds, and assuming at the same time (which is true) that the Supreme Court of the United States has declared bonds originally issued by other counties, under substantially similar circumstances, void; the whole proceeding seems a contrivance and device to escape the judgment of the federal courts. It is submitted that this ought not to be permitted, unless the case is one which can be clearly distinguished from an ordinary action of debt, and brought wholly and completely within the principle of the case of *Rosenbaum vs. Bauer*, even if that case is to stand as law. But the attention of the court is requested to what seems to me a radical differerence between the two cases. Section 645, Chapter 3, Compiled Statutes of Nebraska, declares the purpose of the writ of mandamus: "The writ of mandamus may be issued to any inferior tribunal, corporation, board, or person, to compel the performance of an act which the law specially enjoins as a duty resulting from an office, trust or station. But though it may require an inferior tribunal to exercise its judgment, or

proceed to the discharge of any of its functions, it cannot control judicial discretion."

The purpose of the writ of mandamus then, according to this statute, is to compel the performance of an act which is enjoined as a duty resulting from the holding of an office. Upon the allegation that the bonds in controversy had been adjudged valid, that the treasurer had in his possession funds by law applicable to the payment of the interest coupons upon these bonds, which he refused to apply in payment of said interest, in violation of his duty, a clear case would be made for the writ of mandamus; but where there is no allegation of the adjudication of the validity of the instrument sued upon, a prayer for the mandamus declaring the obligation valid and binding upon the county, exceeds the purpose and intent of the statute, and it is submitted, cannot be reached by that remedy. It does not help the matter that the prayer for judgment is supplemented by the additional prayer that the treasurer shall be required to apply to the payment of that judgment funds in his hands, and applicable to the payment of such judgment, if one was recovered in the ordinary way.

Upon a suit instituted to recover judgment upon these bonds and coupons, the respondents in any court of law would be entitled to a jury trial. By this proceeding, this device, this contrivance, they are ousted of the right to a jury trial, and also prevented from resorting to the only tribunal which has proved a protection against the general repudiation of municipal bonds issued in aid of the construction of railways throughout the northwestern states.

In Rosenbaum vs. Bauer, the prayer of the first suit, after alleging the ownership of the bonds in the plaintiff, that the

treasurer had in his hands $12,000 belonging to the sinking fund applicable to their payment; that plaintiff had tendered his bonds to the treasurer, and demanded that he advertise for proposals for the surrender of the bonds issued under the act, that he refused to do so and that no part of the bonds had been paid, was for judgment that the defendant as treasurer of the city and county of San Francisco *be commanded to advertise for the redemption of Montgomery County bonds*, as in section 11 of the act hereinbefore referred to provided. There was no prayer for a judgment upon the bonds. There does not appear to have been any dispute as to the validity of the bonds. The remedy of the city was wholly against the treasurer in his official capacity to compel him to advertise for the surrender of the bonds as required by law.

There is nothing in the case which shows that there was any controversy between the county, the municipality issuing the bonds, and the creditor. It was wholly and solely a question of the refusal of the treasurer to perform duties conceded to be his by all parties. The second suit set forth that there were no funds in the hands of the treasurer applicable to the payment of any coupons, and that the plaintiff had demanded of the board that it levy a tax sufficient to pay the coupons and that it had refused to do so, and the prayer was for a judgment against the board of supervisors commanding them to levy the tax mentioned and to continue to levy said tax from year to year until all the interest upon the bonds was fully paid.

In both these instances the mandamus prayed for was simply and solely to enforce the duties of a public officer in a case in which there appears to have been no dispute as to the validity of the instruments issued. The whole question was a question of the application of money in the hands of the officer.

In the case at bar, the first thing to be settled, and the first thing in dispute, and the leading thing in dispute, is the validity of the bonds themselves; it being alleged on the part of the defendant that they were issued by the county without any power or authority whatever. It seems, therefore, that the two cases are clearly distinguishable, even if the case of Rosenbaum vs. Bauer is to be accepted as the final determination of the court upon this question. It seems to us impossible to deny the jurisdiction by removal in this case, without turning over this mass of mercantile paper to inevitable repudiation at the hands of the state courts. It is respectfully submitted that no such result ought to be reached by the court.

It is said further that there is a lack of citizenship here necessary to authorize a removal for the reason that the State of Nebraska is the complainant in this case. It seems an impeachment of ordinary intelligence to make the declaration that the State of Nebraska is the real party in interest. The owner of these bonds is a private foreign corporation. It may well be doubted whether as such, under the statute of Nebraska, it can become relator under that provision of the statute which declares: "Any private *person* may on his own relation sue out writs of mandamus without application to the prosecuting attorney." The removal of this case undoubtedly must be settled by the actual character of the relation of the parties in interest as I have stated. That principle is set forth by the court in full in the removal cases, U. S. 100, p. 457.

Neither can the State of Nebraska complain if it undertakes by statute to lend its name to private parties for the prosecution of private ends, and the prosecution of private controversies. It must accept, or ought to accept, all the consequences of that prostitution of sovereignty. In my judgment, it was

never the intention to permit a private person, saying nothing of a foreign corporation, of its own motion, to appropriate the sovereignty of the state in aid of the collection of a private debt. Abundant reason can be seen why, for the enforcement of a public duty, resulting from the possession of a public office, a private party may invoke the writ; unquestionably, such a provision so used and so applied would tend to good government and the preservation and enforcement of public obligations; but, to lend the sovereignty of the state to a private person for the purpose of enforcing the payment of a private debt, a mere money demand, as in this case, is one of those acts not entitled to any special consideration or any special protection. If the state has undertaken to do it, it should be dealt with as having assumed the position of the private party on whose behalf it intervenes. This private party, being the real party in interest, and the action brought being nothing more or less than a civil action to recover a debt, it is not entitled to the immunities ordinarily attaching to suits designed to enforce public duties and to enquire into the duty of public officers.

It is therefore respectfully submitted that the respondents have rightly brought this case to this court by writ of error, and that the suit is of such a nature as to entitle it to removal under the act of March 3, 1875, and that the order of the Circuit Court remanding the same was erroneous and ought to be reversed.

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